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APRIL

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

PROPERTY OF DENTAL

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Enamel, Dentin and Cementum—*Van Kirk*
Tooth Arrangement—*Schwartz*
General Practitioner and Periodontia—*Bryan*
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Original Communications

MECHANICAL AMALGAMATION: PROGRESS REPORT OF RESEARCH ON DENTAL MATERIALS*

By N. O. TAYLOR,† Ph. D., Washington, D.C.

THE available data on dental amalgam alloys have shown that the alloys available to the dental profession vary widely in their composition and properties. Further, the properties of individual alloys were found to vary a great deal as the alloy to mercury ratio was changed and also as the methods of amalgamation were varied. In the past, hand mixing with a preliminary trituration in a mortar has been more or less of an elastic procedure, the total time consumed in mixing being anywhere from two to ten minutes. It has been shown that excessively long trituration in the mortar or mulling in the hand led to serious shrinkage in the final product.[1] With this fact in mind, the question of what effects are to be expected when an alloy is mechanically mixed with mercury seemed to offer an interesting field for research, as, in most mechanical amalgamating devices, the rapidity of agitation is increased, with a corresponding decrease in mixing time.

Little information regarding mechanical amalgamation is available, and such as is offered consists largely of indefinite claims and not of data as to performance. The problem is of sufficient interest to warrant a careful study of the fundamental effects of representative types of amalgamators such as are being

*Cooperative research by the National Bureau of Standards and the American Dental Association.

*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 22, 1928.

†Research Associate, Bureau of Standards.

1. Bureau of Standards Technologic Paper No. 157.

sold to the profession from year to year. Accordingly, a study was made of three types of amalgamators and their effects on the properties of alloys as compared with hand mixed specimens mixed under definitely controlled conditions.

C. A type combining centrifugal and rolling actions on samples placed in a small irregularly shaped box mounted eccentrically on a motor shaft. A mixer of each type was used in this study. They are listed as Type A, B or C,

TABLE 1.—PROPERTIES OF HAND MIXED ALLOYS*

Alloy	Contraction to 1st Minimum in Microns per Cm.	Total Change in 24 Hr. in Microns per Cm.	Percentage of Flow in 24 Hr.	Crushing Strength Lb. per Sq. In.
1	—0.5	+5.0	3.2	46,700
2	—1.5	—1.2	2.5	45,800
3	—60.0	—60.0	†	33,500

*Tests made in accordance with Federal Specification No. 356.
†Both flow samples broke in micrometer.

A survey of the available mechanical devices offered as amalgamators showed them to be of three general types, as follows:

A. Those of the vibrating or shaking type using a gelatin or metal capsule and operated on an eccentric support driven by a motor.

B. The mortar or grinding type of mixer having a metal mortar and an agitator operated by attaching a shaft to the usual dental handpiece.

according to the previous classification.

The selection of variable types of alloys for use in the study made necessary a survey of the properties of current amalgam alloys.[2] Three alloys were selected for test, as follows:

TABLE 2.—PROPERTIES OF ALLOY NO. 1, AS AFFECTED BY VARIATIONS IN MIXING TIME AND BY DIFFERENT TYPES OF AMALGAMATORS*

Property	Amalgamator Type	Mixing Time (Seconds) 15	30	45	60	120	180
Contraction	A	—0.7	—0.9	—1.5	—2.0	—5.5	—11.0
to 1st minimum,	B	0.0	—0.7	—2.4	—5.5	—18.0	
microns per cm.	C	—1.0	—1.5	—3.5	—4.0		
Change in	A	+17.0	+7.0	+2.7	+4.0	+7.0	+2
24 hours,	B	+7.5	+2.2	—3.0	—5.5	—18.0	
microns per cm.	C	+2.7	—1.0	—1.3	—0.6		
Percentage	A	3.2	3.4	5.8	5.9	7.0	9.5
of flow	B	3.3	2.5	2.5	2.7	33.7	
in 24 hours	C	3.2	4.5	8.7	5.2		
Crushing strength,	A	45,100	45,900	56,000	53,500	50,000	47,600
lb. per sq. in.	B	40,700	46,200	48,400	42,600	30,800	
	C	54,200	52,800	53,100	51,900		

*Mixed five parts of alloy to nine parts of mercury by weight. Properties of Alloy No. 1, hand mixed, 5:9, for comparison. To first minimum —0.5; in twenty-four hours, +5; flow in twenty-four hours, 3.2 per cent; crushing strength, 46,700 pounds per square inch.

No. 1. A first quality material whose

2. The results of this survey are given in a separate report, "A Survey of Amalgam Alloys," forwarded to the Research Commission of the American Dental Association.

properties were found to comply with all the requirements of Federal Specification No. 356 for Dental Amalgam Alloys.

No. 2. A material showing a slight shrinkage after twenty-four hours but whose percentage of flow was low and whose crushing strength was fairly high.

No. 3. A very low grade alloy which showed very great shrinkage, whose flow samples crushed under the light loads used in the tests and whose crushing strength was low.

minutes in the hand, are given in Table 1.

With three mixers available and the three alloys mentioned above selected, the experimental work was started and the following series of tests were made:

1. Alloy No. 1 was used in each type of mixer, the proportion of alloy to mercury varying from 5:5 to 5:13 and the mixing time from fifteen seconds to three minutes.

2. Alloys Nos. 2 and 3 were tested in the shaking type of mixer (type A).

TABLE 3.—PROPERTIES OF ALLOY NO. 1 AS AFFECTED BY VARIATIONS IN PROPORTIONS OF ALLOY AND MERCURY*

	Amalgamator	Proportion of Alloy to Mercury by Weight				
Property	Type	5:5	5:7	5:9†	5:11	5:13
Contraction to	A	0.0	0.0	—0.7	—0.6	—0.8
1st minimum,	B	0.0	0.0	0.0	—0.4	0.0
microns per cm.	C	0.0	—0.3	—1.0	—0.4	0.0
Change in	A	+6.0	+16.0	+17.0	+6.0	+12.8
24 hours,	B	+8.5	+7.9	+7.5	+5.0	+10.7
microns per cm.	C	+2.6	+1.8	+2.8	+2.5	+5.5
Percentage	A	3.5	3.7	3.2	4.2	4.6
of flow	B	6.1	2.8	3.3	3.6	4.2
in 24 hours	C	3.2	2.6	3.2	2.9	3.7
Crushing	A	44,900	42,000	45,100	51,800	52,800
strength,	B	39,400	45,400	40,700	47,500	47,000
lb. per sq. in.	C	50,000	51,600	54,200	52,900	47,200

*Mixing time, fifteen seconds.

†Properties of Alloy No. 1, hand mixed, 5:9, for comparison. To first minimum —0.5; in twenty-four hours, +5; flow in twenty-four hours, 3.2 per cent; crushing strength, 46,700 pounds per square inch.

The physical properties investigated in the entire study were setting changes which indicated the contraction to the first minimum and the total change in twenty-four hours expressed in microns per centimeter, the percentage of flow in twenty-four hours, and the crushing strength. All tests were made in accordance with Federal Specification No. 356 for Dental Amalgam Alloys. The physical properties of these alloys mixed five parts by weight of alloy to nine parts of mercury, triturated one minute in a glass mortar and mulled for two

the properties and mixing times varying as in 1. It is interesting to note that no directions were given by the manufacturers of the amalgamators as to proper proportioning or mixing time. Knowing the variations in alloy properties produced by changing manipulatory methods, this would seem a serious omission, more especially so since we have not one but many different types of materials which can be used in these machines. On the other hand, manufacturers of alloys have not seen fit to outline definite treatment for their own

alloys in the various types of amalgamators. The net result is that a variety of mixers have been and are being used without data to prove their limitations and adaptability. It is hoped that this study will give sufficient data to show (1) the effects produced by mechanical amalgamation; (2) the necessity for further study of, and the development of directions for, the individual types of amalgamators; (3) the need for explicit directions for the use of each and every alloy where the manufacturers find their alloy to mercury ratios. These data are given in Tables 3 and 4.

The data secured in testing Alloy No. 1 indicate that:

1. Short mixing times with variable proportions of alloy to mercury give small initial contraction values followed by definite expansion, and, in some instances, excessive expansion.

2. Longer mixing results in larger shrinkage values followed in most cases by incomplete recovery of the loss in length.

TABLE 4.—PROPERTIES OF ALLOY NO. 1 AS AFFECTED BY VARIATIONS IN PROPORTIONS OF ALLOY AND MERCURY*

	Amalgamator	Proportion of Alloy to Mercury by Weight				
Properties	Type	5:5	5:7	5:9†	5:11	5:13
Contraction to	A	—2.8	—3.5	—2.0	—3.1	—2.4
1st minimum,	B	—3.8	—10.5	—5.5	—2.8	—2.4
microns per cm.	C	—3.8	—5.5	—4.0	—4.6	—2.8
Change in	A	+6.3	+6.5	+4.0	+4.5	+6.7
24 hours,	B	—3.8	—8.0	—5.5	—3.1	—4.2
microns per cm.	C	—2.5	—1.6	—0.6	—2.4	+6.0
Percentage	A	4.3	5.3	5.9	5.4	6.1
of flow	B	5.3	9.6	2.7	4.1	7.8
in 24 hours	C	5.8	6.7	5.2	5.8	5.5
Crushing	A	48,200	57,700	53,500	56,900	52,900
strength	B	53,600	52,900	42,600	54,000	53,200
lb. per sq. in.	C	55,700	55,900	51,900	50,500	53,000

*Mixing time, sixty seconds.

†Properties of Alloy No. 1, hand mixed, 5:9, for comparison. To first minimum —0.5; in twenty-four hours, +5; flow in twenty-four hours, 3.2 per cent; crushing strength, 46,700 pounds per square inch.

product adapted to mechanical amalgamation.

The tests of Alloy No. 1 with Amalgamators A, B and C gave three series of data. Samples were made using five parts of alloy to nine of mercury, and the mixing time varied from fifteen seconds to three minutes. This series shows the effect of variations in mixing time independently of other variables. These data are given in Table 2.

The second and third series were run with constant mixing times of fifteen seconds and sixty seconds and variable

3. Flow is increased by increasing mixing time and by increasing the proportion of mercury in the mix.

4. Crushing strength generally increases with mixing time and passes through a maximum point as the proportion of mercury in the mix is increased.

The values obtained in the three mixers are not comparable as the operating characteristics vary widely. The following observations are given to indicate some of these variables.

The type A mixer gave unsatisfactory results, at times due to the characteristics of the gelatin capsules used. These scaled badly, leaving flakes of gelatin in the amalgam when the mixing time was long and the proportion of mercury low. Rapid agitation causes heating and, in mixing for a minute or more, the capsules often fall, scattering amalgam widely. The gelatin capsules also conceal blackening to a considerable extent, although not so completely as if metal any evidence of blackening. Only six samples made in this mixer would pass the Federal specification.

The type C mixer gave more nearly uniform results than either of the other types, but, in this case, it was still evident that conditions must be carefully defined to produce a satisfactory amalgam. Despite the more nearly uniform characteristic, only six of the samples made would pass all requirements.

It is evident that, even when using

TABLE 5.—A COMPARISON OF PROPERTIES OF ALLOYS NOS. 1, 2 AND 3 AS INFLUENCED BY THE TYPE A MIXER*

		Mixing Time (Seconds)				
Property	Alloy No.	15	30	45	60	Hand Mixed
Contraction to	1	—0.8	—0.9	—1.5	—2.0	—0.5
1st minimum,	2	—1.0	—1.5	—4.2	—6.5	—1.5
microns per cm.	3	†				—60.0
Change in	1	+17.0	+7.0	+2.7	+4.0	+5.0
24 hours,	2	+3.5	—0.6	—5.2	—7.5	—1.2
microns per cm.	3					—60.0
Percentage	1	3.2	3.4	5.8	5.9	3.2
of flow	2	2.0	2.1	1.8	3.1	2.5
in 24 hours	3	‡				
Crushing	1	45,100	45,900	56,000	53,500	46,700
strength,	2	45,200	50,100	49,300	52,700	45,800
lb. per sq. in.	3	34,300	§			33,500

*Alloy to mercury ratio, 5:9.

†Preliminary runs indicated that further treatment would not, under any combination of circumstances, cause the setting characteristics of this alloy to meet the specification.

‡Flow specimens were made of Alloy No. 3 for all proportions indicated, and in every case but one, both samples failed in the micrometer.

§Crushing strength specimens of Alloy No. 3 were made only in mixes of fifteen seconds' duration.

capsules are used. In addition, mixes in the same proportion but of varying size were not uniformly mixed. In all, only four samples of Alloy No. 1, mixed in this amalgamator, could be considered as having satisfactory properties.

The type B or grinding type of amalgamator was somewhat more unsatisfactory. Duplicate samples made in it were often characterized by a lack of uniformity caused by a mechanical loss of mercury. This mixer also conceals a first quality material, mechanical amalgamation is of rather doubtful value. Satisfactory amalgams can be made only by carefully defining the proper proportions and mixing times, and even slight variations from these may destroy the valuable properties of our alloys. All types of mixers gave abnormally large expansion values when the mercury content was low and the mixing time short. This would indicate that there is the remote possibility of amalgamating under

very special conditions an alloy which would normally shrink slightly and cause it to pass this part of the specification. It will be interesting to keep this point in mind as we consider the results obtained by testing three types of alloys in the type A mixer.

A series of tests were made using only the type A mixer but with alloys Nos. 1, 2 and 3, mixed in a variety of proportions and mixed for various lengths of times. These data are summarized in Tables V, VI and VII.

TABLE 6.—A COMPARISON OF PROPERTIES OF ALLOYS NOS. 1, 2 AND 3 AS INFLUENCED BY PROPORTIONS OF ALLOY TO MERCURY*

		Proportion of Alloy to Mercury by Weight				Hand Mixed
Properties	Alloy No.	5:5	5:7	5:9	5:11	5:9
Contraction to	1	0.0	0.0	—0.8	—0.6	—0.5
1st minimum,	2	0.0	—0.5	—1.0	—0.8	—1.5
microns per cm.	3	—35.0	—40.0	†		—60.0
Change in	1	+6.0	+16.0	+17.0	+6.0	+5.0
24 hours,	2	+4.5	+5.5	+3.5	+2.8	—1.2
microns per cm.	3	—35.0	—40.0			—60.0
Percentage	1	3.5	3.7	3.2	4.2	3.2
of flow	2	2.3	2.4	2.0	2.0	2.5
in 24 hours	3	‡				
Crushing	1	47,900	42,000	45,100	51,800	46,700
strength,	2	29,700	44,000	45,200	49,100	45,800
lb. per sq. in.	3	32,500	33,700	34,300	34,000	33,500

*Mixing time, fifteen seconds.

†Preliminary runs indicated that further treatment would not, under any combination of circumstances, cause the setting characteristics of this alloy to meet the specification.

‡Flow specimens were made of Alloy No. 3 for all proportions indicated, and in every case but one, both samples failed in the micrometer.

§Crushing strength specimens of Alloy No. 3 were made only in mixes of fifteen seconds' duration.

The results of these tests show that under special conditions as previously mentioned, it may be possible to modify the properties of an alloy that shrinks slightly in hand mixing and actually make it show up better than it would otherwise. The data on Alloy No. 1 have been previously considered. Alloy No. 2 gave satisfactory results as long as the mixing time was fairly short. The data point to the fact that longer mixing times (30 to 45 seconds) may give good results with this alloy provided the proportion of mercury to alloy is low. Alloy No. 3 is so uniformly bad that comments are not in order.

The conclusions drawn from this series of tests of amalgamators and alloys are:

1. Properties of alloys, having satisfactory properties when hand mixed, may be varied to give unsatisfactory results by mechanical amalgamation.

2. In some particular cases slight shrinkage in certain types of alloys may be overcome by a special carefully worked out mechanical amalgamation technic.

3. Manufacturers of amalgamators should supply definite information as to the use of their product.

4. Manufacturers of alloys to be used in amalgamators should furnish the

necessary information to enable their alloys to be satisfactorily used in mechanical amalgamators.

5. Mechanical amalgamation, in its present state of development and standardization, is both a doubtful and a dangerous method and, until more definite data are available for the special type of amalgamator in question, should not be employed by the conscientious dentist with the welfare of his patients in view.

These conclusions must not be taken as a wholesale condemnation of mechanical amalgamation. The field is a comparatively new one, and our data point to further study and development of detailed directions for use as a means of making the process useful and valuable.

TABLE 7.—A COMPARISON OF PROPERTIES OF ALLOYS NOS. 1, 2 AND 3 AS INFLUENCED BY PROPORTIONS OF ALLOY TO MERCURY*

		Proportion of Alloy to Mercury by Weight				
						Hand Mixed
Properties	Alloy No.	5:5	5:7	5:9	5:11	5:9
Contraction to	1	—2.8	—3.5	—2.0	—3.1	—0.5
1st minimum,	2	—3.3	—5.2	—6.5	—4.0	—1.5
microns per cm.	3	†				—60.0
Change in	1	+6.3	+6.5	+4.0	+4.5	+5.0
24 hours,	2	—2.0	—7.0	—7.5	—5.0	—1.2
microns per cm.	3					—60.0
Percentage	1	4.3	5.3	5.9	5.4	3.2
of flow	2	3.0	3.3	3.1	2.5	2.5
in 24 hours	3	36.8				‡
Crushing	1	48,200	57,700	53,500	56,900	46,700
strength,	2	24,800	48,400	52,700	51,500	45,800
lb. per sq. in.	3	§				33,500

*Mixing time, sixty seconds.

†Preliminary runs indicated that further treatment would not, under any combination of circumstances, cause the setting characteristics of this alloy to meet the specification.

‡Flow specimens were made of Alloy No. 3 for all proportions indicated, and in every case but one, both samples failed in the micrometer.

§Crushing strength specimens of Alloy No. 3 were made only in mixes of fifteen seconds' duration.

A SURVEY OF AMALGAM ALLOYS: A REPORT TO THE RESEARCH COMMISSION OF THE AMERICAN DENTAL ASSOCIATION*

By N. O. TAYLOR†, Ph. D., Washington, D. C.

WORK was started at the National Bureau of Standards under the cooperative agreement between the Bureau and the American Dental Association in April, 1928. One of the first studies undertaken was that of mechanical amalgamation, and as various types of alloys were desired for this work, a survey was made of the properties of available amalgam alloys, to give a basis for the selection of alloys for use in this study. The results of this survey were considered of sufficient importance and value to justify their presentation in this special report.

It has long been known that the amalgam alloys available to the dental profession were widely different in their properties, some being regarded as satisfactory and others as definitely of poor quality. Workers in the field of amalgam investigation have given much information as to the properties, but unfortunately have not seen fit to announce the trade names of the materials investigated in their reports. This fact has made it very difficult for the profession to benefit directly from the data secured. While it is true that a few manufacturers may have made use of the information available in the past to improve their products, and the investigations thus led indirectly to some beneficial results, such cases are, unfortunately, few and difficult to verify. In any event, we have with us today an abundance of poor materials and obviously an abunddance of dentists using poor materials. It is hoped that, by using in this report the trade names of the alloys investigated, the data obtained will be of definite value to the dental profession. The report may serve as a protection and encouragement to those manufacturers who are endeavoring to supply alloys of unquestioned quality. It will certainly stimulate the members of the profession to a realization of their obligation to their clients to make sure of the quality of the alloy used.

Samples of amalgam alloys were purchased in the market from various sources to secure representative samples. Attempts were made to secure samples of all the better known alloys, and the specimens secured included practically every alloy advertised in the current dental magazines, together with such others as

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*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug., 22, 1928.

†Research Associate, Bureau of Standards.

it was possible to secure from dental depots.

The alloys investigated were amalgamated exactly as directed by the manufacturers in the few cases in which comprehensive directions were given. In cases in which the manufacturers had not given any details as to manipulation, the alloys were first mixed in the ratio of five parts by weight of alloy to seven parts of mercury, triturated one minute in a glass mortar and then mulled in the hand for two minutes. If this treatment did not seem satisfactory, adjustments were made in the proportions of materials or time of mixing in the mortar and hand until the product was a plastic one having a slight excess of mercury.

TABLE 1.—COMPOSITION OF DENTAL AMALGAM ALLOYS

Sample No.	Brand	Manufacturer	Composition. Per Cent by Weight					
			Silver	Tin	Copper	Zinc	Gold[1]	Platinum[2]
1	Alba	S. S. White	56.3	39.0	3.7	1.0	.....	.....
*2	Banner	Goldsmith Bros.	67.0	27.3	4.8	1.9	0.04	.....
3	Blue Ribbon	J. B. Moyer	57.7	38.9	1.9	0.9	0.50	0.10
4	Brewster (Med.Set)	E. R. S. Brewster	63.9	32.45	2.7	0.9	0.05	.....
*5	Brewster Quick	E. R. S. Brewster	66.1	28.2	4.9	0.8	0.02	.....
*6	Crandall's	Cleveland D. M. Co.	70.2	26.3	3.5[3]	.....	.....	.....
7	Crescent	Consolidated D. M. Co.	54.8	40.5	3.5	1.2	0.01	.....
*8	Dee	T. J. Dee	65.2	29.0	4.8	1.0	0.04	.....
9	Excellent (Ash)	Amalgamated D. Co.	44.0	55.2	0.05	0.75	.....	.....
*10	Fellowship	Dental Protective S. Co.	67.9	26.7	4.9	0.5	.....	.....
11	Gold & Platina	John Hood	44.1	51.0	.....	.....	4.9	.....
12	Gold White	N. K. Garhart	60.2	39.2	.....	0.6	.....	.....
13	Gold White	Harvard Co.	58.9	38.7	1.2	1.2	.....	.....
*14	Harper (Quick Set)	W. E. Harper	68.2	27.1	4.0	0.6	0.04	.....
*15	Minimax 178	Minimax Co.	67.4	26.9	4.7	1.0	0.01	.....
*16	Minimax 183	Minimax Co.	66.8	28.2	3.9	1.1	.....	.....
*17	Mynol	Mynol Chem. Co.	67.0	27.3	4.7	1.0	.....	.....
*18	Ney	J. M. Ney	66.9	27.1	5.0	1.0	.....	.....
*19	Royal	N. K. Garhart	66.7	28.2	4.6	0.5	.....	.....
*20	S-C	Stratford-Cookson	66.6	27.4	5.1	0.9	.....	.....
21	Spencer	E. R. S. Brewster	56.7	36.7	6.3	0.3	0.02	.....
22	Standard	Eckfeldt & Du Bois	53.0	42.7	1.9	.....	2.3	0.12
*23	Trucast	Trucast D. M. Co.	67.6	26.8	5.5	0.1	0.02	.....
*24	True Dentalloy	S. S. White	66.9	26.5	4.9	1.7	.....	.....
*25	Twentieth Century	L. D. Caulk	68.7	26.1	5.0	0.2	.....	.....
26	White	J. B. Moyer	51.8	44.3	2.9	1.0	.....	.....
30[4]	.....	.....	63.3	33.9	2.4	0.4	.....	.....
31	Special 5% Gold Alloy[5]	.....	66.7	33.1	.....	0.2	.....	.....

*Complies with Federal Specification No. 356 as far as chemical composition is concerned.

1. Quantities of gold smaller than 0.1 per cent were estimated colorimetrically.
2. Quantities of platinum were estimated colorimetrically.
3. By difference.
4. Furnished a dental educational institution as a satisfactory filling material.
5. Sold as a 5 per cent gold alloy but contained none.

The amalgamated alloys were tested by standard methods[1] to determine their physical properties. Interferometers were

1. Bureau of Standards Technological Paper No. 157. Federal Specification No. 356 for Dental Amalgam Alloys.

used to follow the setting changes; automatic micrometers, to determine the flow in twenty-four hours, and an Olsen testing machine of 20,000 pounds capacity, to determine the compressive strength. The values for these items were obtained under conditions as outlined in Federal Specification No. 356, the Federal Specifications Board's requirement for dental amalgam alloys.

This specification is at present the only definite standard which has been set up for dental amalgam alloys, and as the data secured in this survey have been used to rate the alloys tested as being satisfactory or unsatisfactory, good or bad, according to its requirements, the specification is given as an appendix to this report.

In Section V of the specification on dental requirements, the requirements for composition and performance as set up cover items which are of great importance from scientific consideration and, as we shall see later, from practical experience in amalgam technic.

No one has ever demonstrated how an amalgam which contracts during the setting period can ever give a perfect restoration. Even slight openings at margins allow the penetration of moisture and bacteria, and the development of further decay is only a matter of time. When we know that certain types of amalgams have a definite and permanent shrinkage, how can one possibly justify their use in the mouth? On the other hand, certain types of alloys expand after a slight initial contraction and exert sufficient pressure on the cavity margins to insure a tight seal of the cavity when setting is complete. Variation in the type of alloy used undoubtedly has a definite bearing on the success of the restorative process, no matter what manipulative skill is employed. Arthur D. Black[2] has indicated that freedom from shrinkage and from excessive expansion are two of the most important properties of satisfactory amalgams and that, unless they are obtained, the alloy must be considered undesirable. His conclusions are concurred in by all who have given the subject serious consideration.

The specification guards against excessive or permanent contraction and against overexpansion by allowing a maximum contraction of 4 microns per centimeter (four ten-thousandths inch per inch) and by requiring that the dimensions at the end of twenty-four hours show an increase in length of from 1 to 10 microns per centimeter length (one ten-thousandth to one one-thousandth inch per inch).

An amalgam must set rather rapidly; first, to permit initial contouring and, secondly, to enable the patient to eat comfortably within two or three hours. An alloy which sets too slowly will certainly be distorted and perhaps rendered valueless as a permanent restoration through strains accidently put on it by the patient. The specification provides that an alloy shall show less than 5 per cent flow or shortening in twenty-four hours when under a load of 250 kg. per square centimeter, the test starting three hours after amalgamation. An alloy complying with this requirement will be strong enough to stand ordinary stresses within three hours or less and will become distorted very little with normal use. If an alloy shows high flow values (some change as much as 25 per cent in twenty-four hours), it will certainly be susceptible to distortion for several days, and contact points and cusps which have

2. Black, A. D.: Progress in Operative Dentistry in Recent Years, J. A. D. A., 15: 1191 (July) 1928.

TABLE 2.—PHYSICAL PROPERTIES OF AMALGAM ALLOYS

Sample No.	Brand	Manufacturer	Contraction to 1st Minimum (Microns per Cm. or Parts per 10,000)	Total Change in 24 Hr. (Microns per Cm. or Parts per 10,000)	Flow Per Cent 250 Kg. per Sq. Cm.	Crushing Strength Lb. per Sq. In.	Directions[1] Alloy to Mercury	Remarks
1	Alba	S. S. White	−32.5	−32.5	14.3	37,100	8 to 7	Blackens hand considerably; sandy
2	Banner	Goldsmith Bros.	− 1.5	+ 3.5	7.9	46,600	None	
3	Blue Ribbon	J. B. Moyer	−16.0	−12.0	9.2	37,600	None	Slow to amalgamate
4	Brewster (Med. Set)	E. R. S. Brewster	− 8.5	− 5.0	2.5	48,000	None	Slight blackening
5	Brewster (Quick)	E. R. S. Brewster	− 1.5	− 1.2	2.5	45,800	None	Slight blackening
*6	Crandall's	Cleveland D. M. Co.	− 0.5	+ 5.0	4.3	44,500	10 to 12	Considerable blackening
7	Crescent	Consolidated D. M. Co.	−30.0	−30.0	25.0	36,700	None	Considerable blackening
8	Dee	T. J. Dee	− 9.0	− 7.5	4.3	48,200	None	Slight blackening
9	Excellent (Ash)	Amalgamated D. Co.	−23.0	−16.5	−2	20,200	6 to 4	
*10	Fellowship	Dental Protective S. Co.	− 0.5	+ 3.0	2.9	51,000	5 to 7	Very slight blackening
11	Gold & Platina	John Hood	−27.0	−27.0	−2	25,000	None	Very dirty; blackens badly
12	Gold White	N. K. Garhart	−56.0	−56.0	−2	33,500	None	Considerable blackening
13	Gold White	Harvard Co.	−12.0	− 9.5	7.2	37,300	None	Very slightly blackening
14	Harper (Quick Set)	W. E. Harper	− 5.5	− 6.5	3.2	50,000	5 to 10	Dirty, leaves mortar black
*15	Minimax 178	Minimax Co.	0.0	+ 4.5	2.6	46,900	None	Very slight blackening
16	Minimax 183	Minimax Co.	− 2.0	− 0.6	1.6	48,700	None	
17	Mynol	Mynol Chem. Co.	− 5.5	− 5.5	6.2	44,100	7 to 9	
*18	Ney	J. M. Ney	− 0.5	+ 5.5	2.2	50,300	7 to 9	Slight blackening
19	Royal	N. K. Garhart	− 4.0	− 2.0	3.5	43,200	None	
20	S-C	Stratford-Cookson	− 4.5	− 5.0	3.7	47,400	5 to 7	
21	Spencer	E. R. S. Brewster	−18.0	−15.0	20.0	39,000	None	
22	Standard	Eckfeldt & Du Bois	−32.0	−32.0	−2	31,400	6 to 5	Considerable blackening
23	Trucast	Trucast D. M. Co.	− 0.7	+ 4.0	5.2	44,600	None	
*24	True Dentalloy	S. S. White	− 0.5	+ 2.5	2.2	46,800	9 to 11	
*25	Twentieth Century	L. D. Caulk	− 0.5	+ 3.5	2.8	54,500	5 to 7	
26	White	J. B. Moyer	−24.0	−23.0	21.0	32,400	None	Slow to amalgamate
27	Copper Amalgam	S. S. White	− 6.0	− 6.0	0.1	48,000		
28	Copper Amalgam	L. D. Caulk	− 1.5	− 1.5	0.1	44,000[3]		
29	Copper Amalgam	W. V-B. Ames Co.	− 4.8	− 4.8	0.1	38,200		

*Alloys whose properties may be considered satisfactory when rated against Federal Specification No. 356.

1. Manufacturers' directions as to proportions and mixing were followed exactly. When no directions were given, proportions were adjusted to give a reasonably plastic product after mixing one minute in a glass mortar and two minutes in the hand.

2. Both flow samples crushed in the micrometers.

3. Other values as low as 18,300 pounds per square inch, depending on the mercury content.

been carefully and laboriously established will disappear and the amalgam will flow out at the gingival margin in a few days, leaving the flat, food-collecting type of contact and a retaining edge at the gum line.

Considerable compressive strength is necessary if the fillings are to stand the strains of mastication over long periods. A specified minimum value of 2,500 kg. per square centimeter has been given to insure satisfactory performance. The values obtained for the compressive strengths of the alloys tested in this survey indicate that the minimum value given in the specification is rather lower than the average of the alloys tested and markedly lower than those of the alloys which have acceptable setting changes and flow characteristics.

The values for chemical compositions represent the composition limits which may, with proper methods of manufacture, amalgamation and condensing, give fillings with satisfactory properties.

A complete discussion of the specifications and the items considered in drafting them was presented to the First District Dental Society of New York.[3]

The chemical compositions of the silver tin base alloys studied are given in Table 1.

For the sake of comparison, we find that the Federal Specification calls for the following proportions, by weight, of metals in dental amalgam alloys: silver, from 65 to 70 per cent; tin, 26 to 29 per cent; copper, 3 to 6 per cent and zinc, 0 to 2 per cent.

The compositions determined fell into general qualitative groups as follows:

1. Alloys in which silver was the only precious metal present.

2. Alloys containing from 0.01 to 0.05 per cent of gold, amounts so small as to indicate that the material was present as an impurity rather than intentionally added.

3. Alloys which contained appreciable amounts of gold and, in two cases, small amounts of platinum. In all cases, alloys of this type had high tin values, and the advantages derived by the addition of gold and platinum, if any actually exist, are offset by the excessive shrinkage, high flow and low strength imparted by the tin.

Quantitatively, fifteen of the alloys studied complied with the composition requirements of the specification, but the data obtained in the physical tests indicate that, while no alloy failing to meet the chemical composition standards may be expected to have satisfactory physical properties, the fact that an alloy may be acceptable as far as composition is concerned is no guarantee that its physical properties will also be acceptable. Physical tests indicate that only 40 per cent of the alloys meeting the chemical requirements were up to standard physically.

Analyses are included for two alloys whose names are omitted. One of these, alloy No. 30, was supplied to a dental educational institution as a filling material. Both chemical and physical properties were unsatisfactory. It is to be hoped that educational institutions will see fit to select alloys on the basis of properties as well as the usual basis of price.

Alloy No. 31 was sold to a dentist who practices in Washington, D. C., as a special alloy containing 5 per cent of gold, and the price was accordingly high. The alloy proved unsatisfactory and an investigation showed a complete absence of gold. The physical properties of the alloy were not determined, but it is safe

3. J. Den. Res., 7:173 (June) 1927.

to predict from the high tin content that the alloy would shrink and flow badly.

The results of the various physical tests are given in Table 2. In considering the data given, it is well to keep in mind the limiting values allowed for contraction, 4 microns per centimeter, for expansion when the final results at the end of twenty-four hours must be between +1 and +10 microns per centimeter, and for flow when 5 per cent in twenty-four hours is the largest amount allowable. The data given covered twenty-six of the common silver-tin base alloys and also include three copper amalgams which are not covered by the specifications but whose characteristics should be of interest.

Little discussion of individual items in the table is necessary.

The alloys may be grouped into several classes, as follows:

1. Those whose properties are satisfactory. These are indicated by an asterisk before them in the table, and are Nos. 6, 10, 15, 18, 24 and 25.

2. Those which have properties meeting the specification, except the one for flow. This class contains alloys Nos. 2 and 23.

3. The group in which flow and strength values are satisfactory but setting changes result in slight shrinkages from the original volume. In this class, we find Nos. 4, 5, 8, 14, 16, 19 and 20.

4. A class which shows excessive shrinkage with little or no recovery, high flow values and low compressive strength, as illustrated by Nos. 1, 3, 7, 9, 11, 12, 13, 17, 21, 22 and 26.

5. Copper amalgam which shows a continuous shrinkage for twenty-four hours, although the total change is less than in many of the alloys of Group 4. Their flow values are satisfactory. The crushing strength values for the copper amalgams are fairly high but erratic, owing, perhaps, to difficulty in heating the material uniformly in amalgamating them according to the directions furnished. The edges chip easily and the alloys do not machine well. The manipulatory methods employed in handling copper amalgams are such that it is very difficult to produce two samples from the same alloy having the same or nearly the

TABLE 3.—SUMMARY OF SURVEY OF AMALGAM ALLOYS; CLASSIFICATION OF ALLOYS IN COMPARISON WITH FEDERAL SPECIFICATION NO. 356.

Properties	Silver—Tin Base Alloys	Copper Amalgams
All satisfactory	6	
Flow excessive; other properties satisfactory	2	
Setting changes alone unsatisfactory	6	
Chemical composition and setting changes unsatisfactory	1	
Chemical composition satisfactory; flow and shrinkage excessive	1	
Crushing strength only satisfactory property	5	
None satisfactory	5	
Setting changes alone unsatisfactory; chemical composition not determined		3
Total	26	3

same physical properties. We may therefore expect wide variation in strength, setting time and other characteristics in our finished products.

The data obtained are summarized in Table 3, which lists the various groups and shows the number of alloys in each. You will note, in totaling up the number of alloys which meet the requirements of the specification, that the result shows six acceptable materials and twenty unsatisfactory ones. When we consider the facts that varying methods of mixing, variable proportions and different methods of condensing may cause variation in the properties of an alloy, it would seem that the data given, together with these other facts, would give adequate explanation for our high proportion of failures in the employment of amalgam.

May we not make some estimates of the probability of constructing an amalgam filling which may give ten or more years of service when inserted in a cavity? How much of the responsibility must you accept as your own? Is 10 per cent a proper allowable loss for poor cavity preparation, incomplete removal of decay and similar items? If so, starting with 100 fillings, we should have ninety acceptable ones, unless influenced by other factors. We know that, in the absence of definite instructions, improper ratios in proportioning, mixing time and methods of condensation may all serve to ruin otherwise good filling materials. With the wide variety of technics employed, would we overestimate if we say that these items cause failure in one in every three fillings? If we accept this value, we will have only sixty of our original 100 fillings that we may expect to give good service, and we still have other factors to consider. We have the patient as a variable factor. Do you suppose that patients ruin less than one in five fillings through carelessness in the first few hours after insertion? One in five would leave only forty-eight of our original 100. Now, when we consider that only about two alloys in nine can possibly give satisfactory fillings, we find that we have only about 11 chances in 100 or 1 in 9 to get an amalgam filling that will give satisfactory service. Is this in accord with your own experience along this line?

These estimates are not offered as scientific data. Your estimates are as good as mine. They do explain why amalgam is often spoken of as a low grade filling material. Some small percentage of amalgam fillings should be satisfactory under present conditions, and the experience of the profession will verify this conclusion. Is it not possible to get 80 or 90 per cent of first rate fillings by selecting our materials carefully, using a reasonable technic and careful cavity preparation? It is; but the profession will never be able to produce a high proportion of satisfactory amalgam fillings until (1) the low grade alloys are replaced by good materials; (2) sufficient directions are furnished for proper manipulation of every alloy, and (3) the profession as a whole believes, and practices as it believes, that good results can be obtained only from good materials properly amalgamated and condensed, and refuses to use untested alloys to save 2 or 3 cents a filling or to use an alloy simply because it works easily.

The data secured showed a high proportion of the alloys in use to be of poor quality. Having the facts in mind, can you picture for yourself the conscientious dentist as a patient comes to him with signs of recurring decay under an amalgam restoration? Will he decide that the failure was due to his own defective

workmanship, perhaps faulty cavity preparation, imperfect adaptation or incomplete condensation, or will he list it as due to insufficient extension for prevention? The first verdict is humiliating and discouraging to the conscientious dentist, and second indicates that injury and expense have been the lot of the patient. The chances are that neither verdict was correct and that the failure should properly be assigned to unsatisfactory and faulty materials. In this case, the responsibility of the conscientious dentist and of the dental profession lies in the selection of first quality materials.

With the facts before us, how shall we remedy the situation? Shall we continue testing samples gathered here and there over the country and periodically report our findings, hoping that the situation will remedy itself? Should the American Dental Association adopt a specification for amalgam alloys and require a guarantee by the manufacturers that their products meet the specification? What further information do we need and what methods shall be employed to better the amalgam situation?

We shall be glad to have your opinion, forwarded through the Secretary of the Executive Board of the Research Commission of the American Dental Association.

The data incorporated in this paper represent the results of tests made on samples of alloys purchased in the open market between April and September, 1928. Development work is continually in progress and several of the alloys found to be unsatisfactory could be made satisfactory by minor changes in chemical composition or in plant procedure. It is hoped that the manufacturers of the satisfactory materials and those who plan to put their materials in the satisfactory group will see fit to guarantee on the individual alloy packages that the enclosed materials comply with Federal Specification No. 356. This would certainly be of great assistance to the dental profession in its selection of amalgam alloys.

DISCUSSION

J. J. Welker, Toledo, Ohio: Has there been any study made over a greater period of time as to the expansion of the high silver content?

Dr. Taylor: That is, of the final results after the twenty-four hours?

Dr. Welker: More than twenty-four hours.

Dr. Taylor: In this particular work, we have not followed them any farther than for twenty-four hours. It takes twenty-four hours to test one sample with the equipment which we have available. We have run these samples through with some of our work on mechanical amalgamation, and at times when our apparatus was in use every day; therefore, we carried this through as rapidly as we could. The data in the table represent about one month's complete utilization of our entire equipment; and if we tied up our instruments over a longer period, we should have been confined to the study of only a few samples. Considerable work has been done in the past on changes over long periods, but we do not have the data at present for the current alloys. We wished to present these data on the alloys available at the present time, in order that you might know what you are paying for.

Wilhelmina Yeretsky, Grand Rapids, Mich.: Was any attention paid to temperature in any of these experiments? Was the temperature kept constant?

Dr. Taylor: We cannot keep temperature constant in the ordinary type of amalgamator, unless we use some special device for controlling it. The heat is generated very rapidly in the crucible; and its control is a rather difficult process. We did keep track of temperature changes by means of a thermocouple inserted into the mix. We found, as we might expect, that the temperature increased very rapidly as the mixing time increased. It varied also as the mercury content increased. The alloys with low proportions of mercury did not heat quite so rapidly. They did not get

into a pellet quite so quickly as the others. We found that we sometimes had, in these amalgamators, a rise of as much as 20 or 25 degrees centigrade. We have evidence that the materials overheat rather badly in mechanical amalgamation, and that is something that must be overcome, if we are going to standardize amalgamating devices.

W. E. Harper, Chicago, Ill.: In this presentation, it is rather unfortunate the most important quality in dental amalgamations has been omitted, and that is adaptability. Measurement of movement is not a measurement of adaptability; and, in twenty years' work, I find that our fillings fail as a result of lack of adaptation, whether that lies in the material or in the operation; and I hope the Bureau of Standards may see fit to add to their tests adaptability. I think it will be found the most important of all essential qualities in dental alloys.

B. C. Amundsen, Duluth, Minn.: Have you observed the difference in mixing if you leave the mortar out entirely, just using the palm of the hand.

Dr. Taylor: The chief difficulty is in starting amalgamation. It would take, with ordinary treatment, probably a minute and a half in the hand to get the equivalent of the starting point in the mortar. The difficulty is in getting the alloy definitely in contact with the mercury, and that, as I see it, is the advantage of the mortar. Some people prefer to mix it in the mortar three minutes; others like to mull it in their hands. In either case, satisfactory results should be had within three minutes, provided the material is all right to start with. We will get variations if we continue too long, or mix too rapidly. With average material, we can get very good amalgamation in three or three and a half minutes.

A. K. Steen, Fond du Lac, Wis.: Did the speed at which the man operates the mixer affect the result? Would a low speed for a longer period be better than a high speed for a shorter period?

Dr. Taylor: As far as results are concerned, the time was too short to permit very much of a study of that particular item on any one mixer. We have been at this work four or five months, and the time involved with the large number of samples which we tried made it impossible to study that factor. We have set, in our shaking amalgamator, a definite speed, the speed indicated by the manufacturer of the mixer. With the grinding type, we have had to employ a speed which would keep the mixture in the mortar. Speeding up the grinding type of mixer would, at times, throw the mercury out so rapidly that we would get no mixture at all.

G. W. Akerly, Milford, Ill.: Was there any milling of the mixture after the mechanical mixing?

Dr. Taylor: The only attempt we made to do anything with the alloy after mechanical mixing was when the material had too high a proportion of mercury to allow it to condense properly. The excess mercury was expressed with chamois or between the fingers. There was no mixing in the hand.

Wilmer Souder, Washington, D. C.: The moral of this paper today is: Get a good alloy first and work out methods afterwards. Do not try for adaptation when depending on poor alloy, because you will be doomed to failure at the start. Get good alloys, and your work will improve.

APPENDIX
FEDERAL SPECIFICATION BOARD
SPECIFICATION NO. 356

UNITED STATES GOVERNMENT
MASTER SPECIFICATION
FOR
DENTAL AMALGAM ALLOY

I. GENERAL SPECIFICATIONS

There are no general specifications applicable to this specification.

II. TYPES

The following types shall be furnished, as ordered:

Type A. Shavings.
Type B. Fillings.

III. MATERIAL

The comminuted alloy shall be free of foreign materials and shall be uniform.

IV. GENERAL REQUIREMENTS

Amalgams shall possess the following features, known as satisfactory working qualities:

1. Thorough amalgamation in 3 minutes.
2. Absence of granular or sandy consistency when amalgamated.
3. Susceptibility to carving for at least 15 minutes after amalgamation.
4. Susceptibility to receiving and retaining a polish 24 hours after amalgamation.

V. DETAIL REQUIREMENTS

1. Chemical Composition.—The chemical composition shall be within the following limits:

Silver	64 to 70 per cent
Tin	26 to 29 per cent
Copper	3 to 6 per cent
Zinc	0 to 2 per cent

2. Ultimate Compressive Strength.—The average ultimate compressive strength values of three or more tests shall not fall below 2,500 kilograms per square centimeter (approximately 35,500 pounds per square inch).

3. Flow.—Specimens subjected to a constant pressure of 250 kilograms per square centimeter (approximately 3,550 pounds per square inch) shall not show more than 5 per cent flow (i. e. more than 5 per cent shortening in length of specimen) in a period of 24 hours.

4. Setting Changes.—Twenty-four hours after amalgamation the length shall have increased between 1 and 10 microns per centimeter. If at any time during the test a contraction of more than 4 microns per centimeter is detected, the alloy shall be rejected.

VI. METHOD OF SAMPLING AND TESTS

1. At least 1 ounce shall be taken at random from every 500 ounces or fraction thereof for test at time of delivery.

2. Ultimate Compressive Strength.—Specimens shall be cylinders 6 mm. in diameter and 12 mm. long. These shall be prepared by condensing the amalgam into a cavity of these dimensions in a rigid block, using a reasonable technic (approximately that given in the sheet of instructions accompanying the alloy).

The ends of the cylinders shall be surfaced at right angles to the axis. Strength tests shall be made 5 days after condensing and the actual time consumed in applying the load shall not be over 5 minutes nor under 2 minutes. Tests shall be made at temperatures between 20 and 25 degrees Centigrade.

3. Flow.—Specimens shall be cylinders 4 mm. in diameter and 8 mm. long and shall be prepared in the same manner as those for crushing. Three hours after condensing, the specimen shall be subjected to a constant pressure of 250 kilograms per square centimeter (approxi-

mately 3,550 pounds per square inch). During this test, the specimen shall be maintained at a temperature between 20 and 25 degrees Centigrade.

4. Setting Changes.—Specimens shall be prepared by condensing into a cavity or matrix. These shall be removed as soon as condensation is completed and shall not be subject to restraint during the test. Measurements shall begin 15 minutes after amalgamation. (Time spent in mulling and condensing to be included as a part of the 15 minutes.)

VII. PACKING

1. Alloy shall be packed in moisture resisting containers and in quantities of 1 or 5 ounces as may be specified.

2. Instructions for manipulation must accompany each package.

VIII. NOTES

1. The foregoing specification is for the so-called "silver" amalgams which are to be used for restorations in the mouth.

2. Instruments and methods suitable for measuring the physical properties of alloys are described in Bureau of Standards Technologic Paper No. 157 and in the *Dental Cosmos*, March, 1920, pp. 305-335. It is not desired to limit the tests to the types of apparatus mentioned therein; on the contrary, any approved device, the accuracy of which is proved equal to those named, may be used.

3. Bids shall be in terms of ounces, Troy (31.1 grams).

A FURTHER STUDY OF THE FREQUENCY OF OCCURRENCE OF CERTAIN STRUCTURAL VARIATIONS IN HUMAN ENAMEL, DENTIN AND CEMENTUM*

By LAWRENCE E. VAN KIRK, A.B., D.D.S., Pittsburgh, Pa.

THE frequency of occurrence of the following structural variations in the hard tissues of human teeth has been determined by the examination of 1,000 ground sections: (1) enamel spindles; (2) granular rods; (3) secondary deposits in the pulp chamber or root canal, and (4) variations in arrangement of the enamel, dentin and cementum at the gingival line.

The sections examined were from the collection in the Histology Department of the University of Pittsburgh Dental School. Very few of the sections were made from carious teeth, nearly all of them being free from caries, except for slightly defective areas in pits and fissures. The result of the examination of the first 450 sections has already been published,[1] and the conclusions stated at that time were further justified by the subsequent study of 550 more.

Table 1 gives the results of the former investigation of 450 sections.

The results in the second group of 550 sections are given in Table 2. The combined results of Tables 2 and 4 are

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

1. Van Kirk, L. E.: Variations in Structure of Human Enamel and Dentin, J. A. D. A., 15:1270 (July) 1928.

given in Table 3. Table 4 gives the results according to the location of the teeth.

SUMMARY

Enamel spindles are found in practically all posterior teeth and in all the anterior teeth in which the incisal portion of the dentino-enamel junction was not destroyed, either in grinding or by attrition. Where they were not found in the anterior teeth, it was because that portion of the tooth in which they are concentrated was missing. In the posterior teeth, they are found not only around the cusp tips just externally to the dentin, but also along the axial portions of the dentino-enamel junction.

The granular rods were found in 998 of the 1,000 sections, which justifies the former conclusion that they are universally seen in ground sections. The two sections where they were not seen were so thin that it was difficult to differentiate the structures. Whether these are areas of hypoplastic enamel or are the result of the grinding process, or they are, perhaps, such areas of enamel exaggerated by grinding, is not known.

A consideration of the occurrence of secondary calcific deposits in the pulp

Table 1.—Results of Investigations on Four Hundred and Fifty Teeth (First Group)

Teeth	Number Examined	Enamel Spindles		Granular Rods		Secondary Deposits			Gingival Tissues					
		Present	Absent	Present	Absent	Present	Absent	Undetermined	Junctions Examined	Cementum Overlaps Enamel	Cementum Meets Enamel	Enamel Overlaps Cementum	Dentin Exposed	Undetermined
Upper central incisors	50	24	26	50	0	40	7	3	100	30	10	1	14	45
Upper lateral incisors	50	34	16	50	0	32	7	11	100	19	27	2	6	46
Upper cuspids	50	35	15	50	0	36	2	12	100	36	13	0	7	44
Upper bicuspids	50	50	0	50	0	19	23	8	50	25	6	0	0	9
Upper molars	50	49	1	50	0	16	30	4	51	31	6	0	1	13
Lower incisors	50	38	12	50	0	32	6	12	82	18	12	1	10	41
Lower cuspids	50	39	11	50	0	31	15	4	82	40	5	2	1	34
Lower bicuspids	50	49	1	49	1	26	19	5	100	43	8	1	1	47
Lower molars	50	50	0	50	0	27	23	0	100	55	12	0	0	33
Total All teeth	450	368	82	449	1	259	132	59	765 443	297	99	7	40	322
Percentage, based on all junctions not destroyed in grinding										67	22.4	1.58	9	

chamber reveals many interesting facts. Since various numbers of each type of tooth were examined, the reduction of the results to percentages renders comparison easier. Table 5 gives the percentage of the various groups in which secondary deposits were found. The number of sections in which the presence of these deposits could not be accurately determined was deducted from the total number as a basis for the percentage.

The percentages for the various teeth are given in Table 6.

The highest frequency was found in the lower incisors with 97.2 per cent, followed by the upper cuspids, with 93 per cent. The lowest frequency occurred in the upper molars, with 44.3 per cent. The average for the group of 790 in which the presence or absence of deposits could be definitely determined was 72.9 per cent.

The results of the investigation of the tissues at the neck of the tooth justify the earlier conclusion that, in the majority of teeth, the cementum overlaps the enamel. The results in percentage of junctions, from which determinations could be made, are given in Table 7.

Comparison of the percentages from the examination of 1,000 teeth, from which group 1,014 relations were determined, and the same results from the

TABLE 2.—RESULTS OF INVESTIGATIONS ON FIVE HUNDRED AND FIFTY TEETH (SECOND GROUP)

		Enamel Spindles		Granular Rods		Secondary Deposits			Gingival Tissues					
Teeth	Number Examined	Present	Absent	Present	Absent	Present	Absent	Undetermined	Junctions Examined	Cementum Overlaps Enamel	Enamel Meets Cementum	Enamel Overlaps Cementum	Dentin Exposed	Undetermined
Upper central incisors	103	50	53	103	0	86	12	5	206	62	39	2	21	82
Upper lateral incisors	99	52	47	98	1	66	11	22	198	49	40	2	13	94
Upper cuspids	49	21	28	49	0	31	3	15	98	42	13	0	5	38
Upper bicuspids	50	50	0	50	0	16	12	22	100	32	13	2	3	50
Upper molars	49	49	0	49	0	18	13	18	98	47	11	0	2	38
Lower incisors	50	22	28	50	0	30	3	17	100	15	10	3	2	70
Lower cuspids	50	26	24	50	0	28	1	21	100	30	13	0	1	56
Lower bicuspids	50	50	0	50	0	24	4	22	100	26	11	0	3	60
Lower molars	50	50	0	50	0	18	23	9	100	51	8	0	0	41
Total All teeth	550	370	180	549	1	317	82	151	1,100	354	158	9	50	529
Percentage, based on junctions not destroyed in grinding										62	27.7	1.58	8.7	

study of the first 450 teeth, with 443 junctions, is given in Table 8.

From these results, it is evident that the cementum usually overlaps the enamel, while the enamel rarely covers the cementum at their junction. The overlapping cementum is far more frequent in the posterior teeth, the lower molars having 84 per cent of this relation at the gingival. The upper lateral incisors have only 43 per cent, this being the lowest percentage of the group. The general average of this condition for the entire group is 64 per cent.

The cementum and enamel failed to meet in 8.87 per cent of the 1,000 sections, this condition being found most frequently in the anterior teeth, the upper central incisors showing a percentage of 19.5. In the lower molars, no exposed dentin was seen in the examination of 126 junctions.

TABLE 3.—COMBINED RESULTS OF TABLES 1 AND 2

		Enamel Spindles		Granular Rods		Secondary Deposits			Gingival Tissues					
Teeth	Number Examined	Present	Absent	Present	Absent	Present	Absent	Undetermined	Junctions Examined	Cementum Overlaps Enamel	Cementum Meets Enamel	Enamel Overlaps Cementum	Dentin Exposed	Undetermined
Upper central incisors	153	74	79	153	0	126	19	8	306	92	49	3	35	127
Upper lateral incisors	149	86	63	148	1	98	18	33	298	68	67	4	19	140
Upper cuspids	99	56	43	99	0	67	5	27	198	78	26	0	12	82
Upper bicuspids	100	100	0	100	0	35	35	30	150	57	19	2	3	69
Upper molars	99	98	1	99	0	34	43	22	149	78	17	0	3	51
Lower incisors	100	60	40	100	0	62	9	29	182	33	22	4	12	111
Lower cuspids	100	65	35	100	0	59	16	25	182	70	18	2	2	90
Lower bicuspids	100	99	1	99	1	50	23	27	200	69	19	1	4	107
Lower molars	100	100	0	100	0	45	46	9	200	106	20	0	0	74
Total All teeth	1,000	738	262	998	2	576	214	210	1,865	651	257	16	90	851
Percentage, based on all junctions not destroyed in grinding										64.2	25.34	1.58	8.87	

CONCLUSIONS

This further investigation, which makes a total of 1,000 sections examined, justifies the following conclusions:

1. The enamel spindles are found in practically all teeth. In the anterior teeth, they are concentrated in the enamel, just outside the dentin along the incisal portion. In the posterior

TABLE 4.—RESULTS GROUPED ACCORDING TO LOCATION OF TEETH

Teeth		Number Examined	Enamel Spindles: Present	Enamel Spindles: Absent	Granular Rods: Present	Granular Rods: Absent	Secondary Deposits: Present	Secondary Deposits: Absent	Secondary Deposits: Undetermined	Gingival Tissues: Junctions Examined	Gingival Tissues: Cementum Overlaps Enamel	Gingival Tissues: Enamel Meets Cementum	Gingival Tissues: Enamel Overlaps Cementum	Gingival Tissues: Dentin Exposed	Gingival Tissues: Undetermined
Anterior teeth	Upper	401	216	185	400	1	291	42	68	802	238	142	7	66	301
	Lower	200	125	75	200	0	121	25	54	364	103	40	6	14	249
	Total	601	341	260	600	1	412	67	122	1,166	341	182	13	80	550
Posterior teeth	Upper	199	198	1	199	0	69	78	52	299	135	36	2	6	120
	Lower	200	199	1	199	1	95	69	36	400	175	39	1	4	181
	Total	399	397	2	398	1	164	147	88	699	310	75	3	10	301
Upper teeth		600	414	186	599	1	360	120	120	1,101	373	178	9	72	469
Lower teeth		400	324	76	399	1	216	94	90	764	278	79	7	18	382
Total All teeth		1,000	738	262	998	2	576	214	210	1,865	651	257	16	90	851

TABLE 5.—PERCENTAGES OF VARIOUS GROUPS IN WHICH SECONDARY DEPOSITS WERE FOUND

	Number Accurately Determined	Number with Deposits	Percentage with Deposits
In the entire group	790	576	72.9
In all upper teeth	480	360	75.0
In all lower teeth	310	216	69.7
In all anterior teeth	479	412	86.0
In all upper anterior teeth	333	291	87.4
In all lower anterior teeth	146	121	83.6
In all posterior teeth	311	164	52.4
In all upper posterior teeth	147	69	46.9
In all lower posterior teeth	164	95	57.9

TABLE 6.—PERCENTAGES FOR THE VARIOUS TEETH

	Number Accurately Determined	Number with Deposits	Percentage with Deposits
Upper central incisors	145	126	86.9
Upper lateral incisors	116	98	84.5
Upper cuspids	72	67	93.0
Upper bicuspids	70	35	50.0
Upper molars	77	34	44.3
Lower incisors	71	69	97.2
Lower cuspids	75	59	78.6
Lower bicuspids	73	50	68.5
Lower molars	91	45	49.4

teeth, they are more generally distributed, many being found well up toward the gingival.

2. The granular rods are found in all ground sections that are thick enough to permit differentiation of structural elements in the tissues.

3. Secondary deposits of calcified material in the pulp chambers of the teeth were frequently found. The anterior teeth show a higher incidence of this condition than do the posterior teeth.

4. The cementum overlapped the enamel at the gingival line in the majority of the sections, especially in the posterior teeth. The tissues meet in

TABLE 7.—RESULTS IN PERCENTAGE OF JUNCTION

Tooth	Number Examined Not Damaged in Grinding	Cementum Overlapping Enamel Per Cent	Enamel Meets Cementum Per Cent	Enamel Overlapping Cementum Per Cent	Dentin Exposed Per Cent
Upper central incisors	179	51.4	27.30	1.7	19.50
Upper lateral incisors	158	43.6	42.40	2.5	12.00
Upper cuspids	116	67.2	22.40	0	10.40
Upper bicuspids	81	70.4	23.50	2.4	3.70
Upper molars	98	80.6	17.30	0	1.10
Lower incisors	71	46.5	30.90	5.6	17.00
Lower cuspids	92	76.1	19.60	2.1	2.10
Lower bicuspids	93	74.2	20.40	2.1	4.30
Lower molars	126	84.0	16.00	0	0
All teeth	1,014	64.3	25.34	1.58	8.87

about 25 per cent of the junctions studied. The enamel rarely overlaps the cementum. The enamel and cementum fail to meet, leaving the dentin exposed in less than one tenth of the junctions that were examined. This condition is more frequent in the anterior teeth.

TABLE 8.—COMPARISON OF PERCENTAGES

	1,000 teeth	450 teeth
Cementum overlapping enamel	64.20	67.00
Cementum meeting enamel	25.34	22.40
Enamel overlapping cementum	1.58	1.58
Dentin exposed	8.87	9.00

SOME IMPORTANT CONSIDERATIONS IN TOOTH ARRANGEMENT*

By MAX M. SCHWARTZ, D.D.S., Jersey City, N. J.

IT is not the purpose of this paper to discuss the many methods of tooth arrangement in vogue, but rather to present a new conception of tooth articulation and tooth form.

It is generally conceded that, in constructing artificial dentures, teeth should be arranged to produce a pleasing, esthetic effect. This presupposes accurate mouth records, the proper opening relation, the selection of a mold harmonious with the facial form and size of the individual patient, a hue or mixture of hues which blend with the surrounding anatomy, and an arrangement of teeth to portray an appearance of natural dentition. The esthetic effect is further enhanced by the restoration of facial contours through the manipulation of the denture base. The fundamental principles governing these factors have been aptly presented by Clapp,[1] Williams, Sears,[2] Owen,[3] Vehe[4] and Bruening.[5] A close application of the principles involved permit of a high degree of beauty. However, the numerous variations and combinations permit of esthetic results only in direct proportion to the artistic skill and ability of the operator in blending the various factors.

The arrangement of the posterior teeth may aid or mar the beauty obtained through the arrangement of the anterior teeth. Attention must be paid to the plane of orientation and compensating curve, if the esthetic result obtained through the arrangement of the anterior teeth is to be maintained. (Figs. 1-5.)

Natural phonation should accompany a harmonious esthetic result. Beauty is desirable and certainly clarity of speech is to be commended. Artificial teeth should be arranged, therefore, with a regard to phonetics as well as esthetics. The close relationship existing between these two phases of denture construction becomes increasingly apparent as one applies in practice the principles involved. The relation of phonetics and tooth arrangement has been carefully considered by Peters,[6] Wright[7] and Tench,[8] whose writings are recommended.

In obtaining good phonetic and esthetic results, one must bear in mind that, for stability, the most favorable

*Read before the Section on Full Denture Prosthesis at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 23, 1928.

1. Clapp, G. W., and Tench, R. W.: Professional Denture Service, New York: Dentists Supply Company, 1918.

2. Sears, V. H.: The Art Side of Denture Construction, Dent. Digest, 29:764 (Nov.) 1923.

3. Owen, E. B.: Determining Hues and Shades in Edentulous Cases, J. A. D. A., 12:944 (Aug.) 1925.

4. Vehe, W. D.: Esthetics in Restorative Procedures, J. A. D. A., 15:1261 (July) 1928.

5. Bruening, E. H.: Study of Facial Forms and Complexion Colors, J. A. D. A., 13:1564 (Nov.) 1926.

6. Peters, E. K.: Esthetics by Lip Action; published by the author, at Fresno, Calif.

7. Wright, W. H.: Simplified Phonetic Tests for Use in Prosthetic Restoration, Dental Engineering, Vol. 1, Ed. 1, Buffalo, N. Y.: Hanau Engineering Co., 1926.

8. Tench, R. W.: Influence of Speech Habits on the Design of Full Artificial Dentures, J. A. D. A., 14:644 (April) 1927.

positions for the incisal edges of the mandibular anterior teeth are over the crest of the mandibular ridge. It is generally accepted today, from the point of view of mechanics and physiology, that balanced articulation[9] is desirable; first, to assist in stabilizing the dentures during function; and, secondly, to minimize the trauma to the tissues underlying the denture bases.

Fig. 1.—Patient wearing old dentures.

Fig. 2.—Patient shown in Figure 1, wearing new dentures. Note restoration of facial expression.

To minimize trauma, we must, obviously, have the maximum of stability of the dentures upon their supporting tissues. This will be obtained if, during function, the forces of occlusion are at right angles to the supporting areas. This, in turn, necessitates directing the forces of occlusion at right angles to the tooth guidances which must lie parallel with, and directly over, the crests of the supporting areas.

A practical means of obtaining maximum stability with minimum trauma is by use of the "articulating center" of Sears. Let us consider the area anterior to the second molar region of the mandibular ridge as the area of greatest support. If we erect a perpendicular

9. Hanau, Rudolph: Articulation, Defined, Analyzed and Formulated, J. A. D. A., 13:1694 (Dec.) 1926. Sears, V. H.: Balanced Occlusions, J.A.D.A., 12:1448 (Dec.) 1925; Articulator Adjustments and Tooth Arrangement, Lab. Technician, 1:1 (Oct.) 1927; Suggestions for Arranging Channel Posteriors, ibid., 1:8 (May) 1928; Channel Type Posterior Tooth Forms, J.A.D.A., 15-1111 (June) 1928; Suggestions for Grinding Channel Posteriors, Lab. Technician, 1:9 (June) 1928.

from the middle of this area and a perpendicular from the middle of the condyle guide, the intersection of the perpendiculars will give us the "protrusive articulating center." (Fig. 6.)

All guides and guidances must face this center to assure balanced articulation in the centric-protrusive movement. The placement of all guides and guidances so that they face the protrusive articulating center will insure protrusive balance, regardless of the other factors, such as compensating curve, plane of orientation and cusp height.

Let us investigate the centric-protrusive movement. We have fixed on the articulator the condyle indication. This must not be changed because it has been given to us by the patient. In order to set the teeth, we have on the instrument, for convenience, the incisal guide. This acts as a guide in the anterior region in the same manner as the condyle guide acts in the posterior region. The incisal guide is the one factor that may be adjusted to meet the practical tooth guidance requirements in harmony with the given condyle guides. Before the advent of the articulating center, it was not known how to set the incisal guide in accordance with the principles herein stated. Now we know that the incisal guide must face the articulating center; in other words, the protrusive articulating center may be

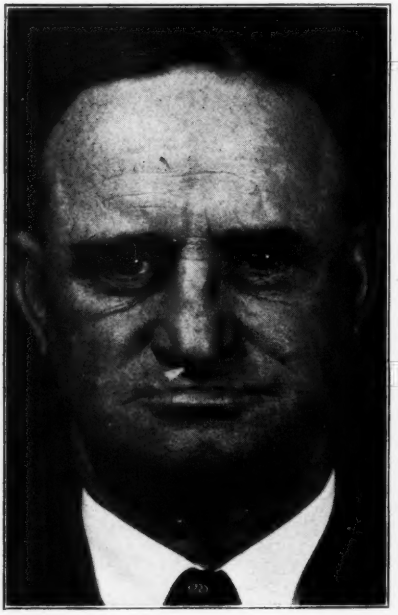

Fig. 3.—Patient shown in Figures 1 and 2, wearing old dentures.

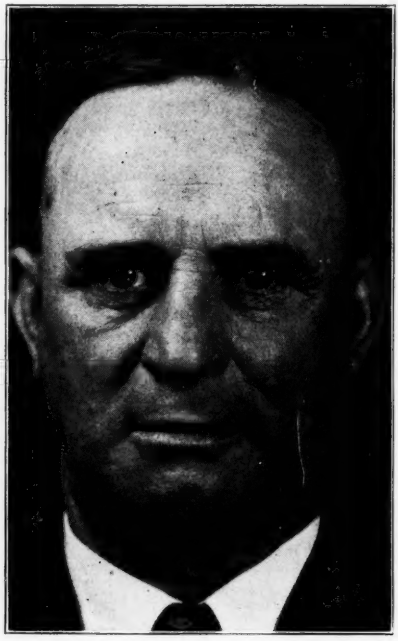

Fig. 4.—Patient shown in Figures 1-3, wearing new dentures.

definitely designated as being the point of intersection of two perpendiculars erected from the middle of the condyle guide, and the middle of the area of greatest support of the mandibular ridge, respectively, and all other guides including the incisal guide must face this same center. (Fig. 6.)

When arranging the posterior teeth,

Fig. 5.—Patient shown in Figures 1-4, wearing new dentures.

we need as our guides only the condyle guide and the incisal guide. If these have been properly set, they will determine for us the protrusive articulating center, and the teeth will be guided by these so that tooth guidances will face the favorable articulating center previously fixed. This will assure, in a scientific manner, the greatest possible stability of the dentures upon their supporting tissues during protrusive-retrusive movements.

Let us take some concrete examples. Assume a case in which the condyle guide and the incisal guide are horizontal. In such a case, the perpendicular erected upon the guides meet in infinity, and the protrusive articulating center is in infinity. (Fig. 7.)

Let us now keep the condyle guide horizontal and move the incisal guide

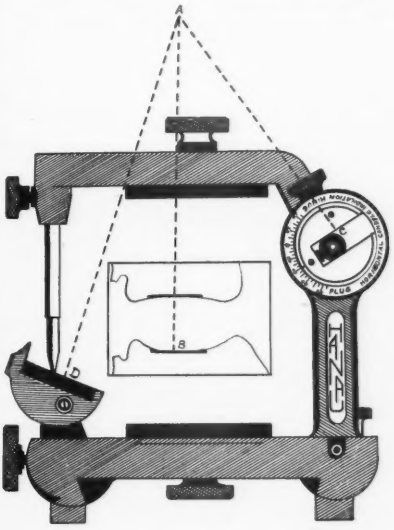

Fig. 6.—Graph showing the protrusive articulating center *A* obtained by drawing perpendiculars from the middle of the area of greatest support *B* of the mandibular ridge (black area) and the middle of the condyle guide *C*. The incisal guide must face the articulating center and should be so set that a perpendicular erected upon the middle of the incisal guide *D* will pass through the articulating center *A*.

toward the negative. The perpendiculars erected upon the guides meet at a point above the condyle guide, making the protrusive articulating center above the condyle guide. (Fig. 8.)

Let us keep the condyle guide horizontal but make the incisal guide steep. The perpendiculars now meet below the condyle guide and make the articulating center below the condyle guide. (Fig. 9.)

These examples show that the protrusive articulating centers may be above or below the condyle guide. In these cases, we kept the condyle guide fixed and obtained different articulating centers in different positions by changing the inclination of the incisal guide.

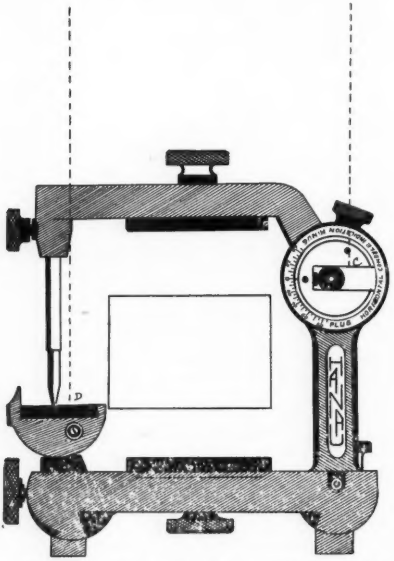

Fig. 7.—Graph showing condyle guide and incisal guide horizontal. The perpendiculars *C* and *D* erected upon the guides meet in infinity. Therefore, the articulating center is in infinity.

Let us now keep the incisal guide fixed in a horizontal position and note what changes may be brought about by difference in inclination of the condyle guide. In such a case, when the condyle guide is given a positive indication, the protrusive articulating. center is above the incisal guide (Fig. 10), and when the condyle guide is inclined toward the negative, the protrusive articulating center is below the incisal guide. (Fig. 11.)

Different protrusive articulating centers may also be determined by changing the inclinations of both condyle guides and incisal guide, keeping neither fixed. For example, we may make both guides simultaneously steep or both simultaneously flat, or one steep and one flat simultaneously.

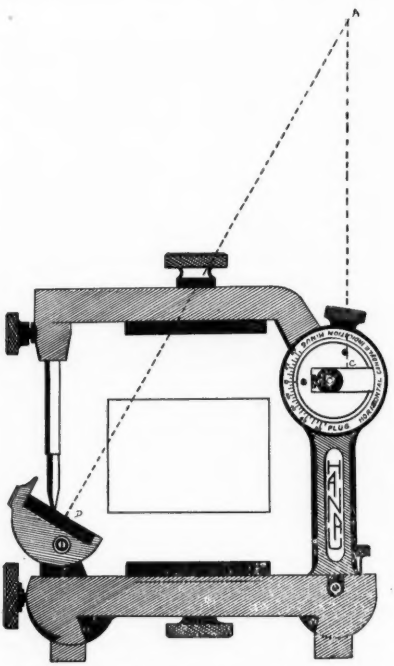

Fig. 8.—Articulating center *A* above the condyle guide.

From these illustrations, the following conclusions are drawn:

1. The intersection of two perpendiculars determines a center.

2. The intersection of a perpendicular erected from the middle of the condyle guide and a perpendicular erected from the middle of the area of greatest support of the mandibular ridge determines the protrusive articulating center.

3. The protrusive articulating center may be above the plane of orientation, or below the plane of orientation, near this plane or in infinity.

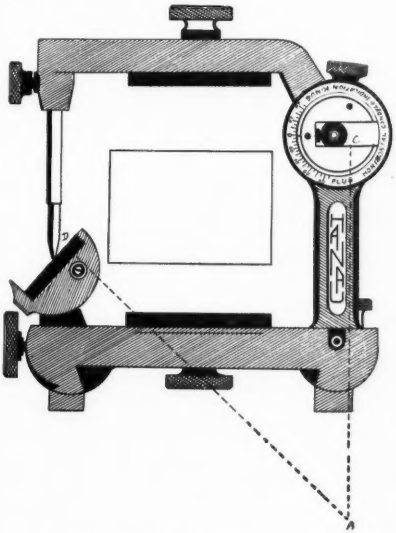

Fig. 9.—Articulating center *A* below the condyle guide.

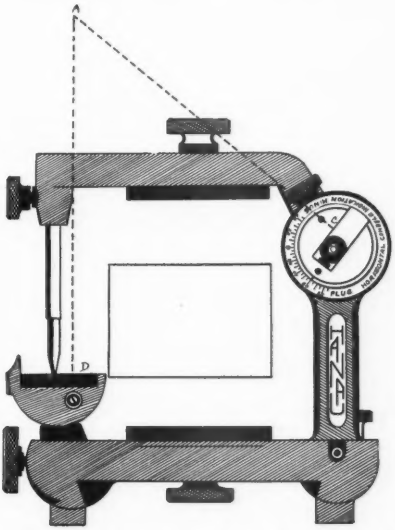

Fig. 10.—Protrusive articulating center *A* above the incisal guide.

4. Changes in the inclinations of the incisal guide, or the condyle guides, separately or simultaneously, will change the protrusive articulating center.

Opening the articulator does not alter the relation of the condylar guide to the area of greatest support of the mandible in most articulators now in use. If the maxillary area does not correctly oppose the mandibular area, it is impossible to arrange protrusive tooth facets parallel with both ridges. The weaker member should be favored when any favoring is required.

It should be understood that the articulating center desired is the one which is coincident with a center of which the area of greatest support of the mandibular ridge is an arc or tangent.

So far, we have determined the protrusive-centric articulating center as a point. It may be either a fixed point or a moving point. If the guides are arcs of the articulating center, that center is a point. If the guides are straight, as in most articulators, the articulating center is a series of instantaneous points or a locus.

When the articulator with straight guides is in centric relation, the point is at *A* (Fig. 12). As the mandible moves to protrusive relation, the point moves to *B*. As the movement continues to a farther protrusive relation, the

point moves to *C*. From this, we learn that every intermediate movement from centric to protrusive relation has its own center. We infer, therefore, that the centric-protrusive articulating center of most articulators is not a fixed point but rather the path of a moving point in space. To state this in another way, it is a locus.

We may note here that since the protrusive articulating center is not always a fixed point, it cannot always be the center of a sphere. If it cannot always be the center of a sphere, a sphere cannot always be used to build dentures.

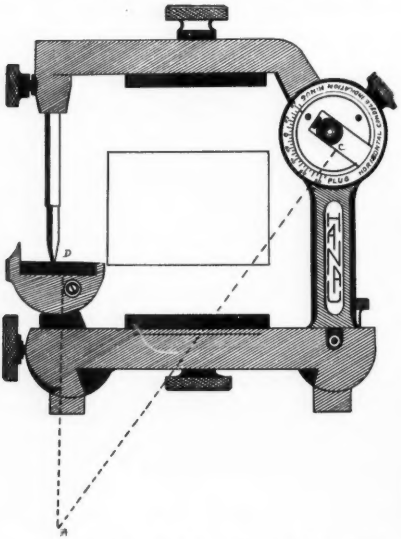

Fig. 11.—Articulating center *A* below the incisal guide.

To prove to oneself that the compensating curve is not the factor which insures balance as has been commonly supposed, one may make a few simple experiments. First, consider a case where there is a sharp compensating curve. We may totally disregard the compensating curve and still obtain protrusive balance. We need merely to face the tooth guidances toward the articulating center determined by the incisal and condyle guides. The teeth may be placed on a flat line (Fig. 13) or even in a reverse curve (Fig. 14), and balance will be obtained in this manner despite the fact that the compensating curve is a sharp, positive curve.

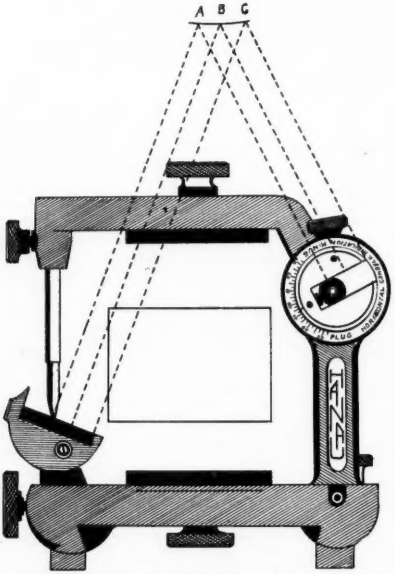

Fig. 12.—Graph showing that the protrusive articulating center is not a fixed point when the guides are straight or when they are not concentric arcs of the same center. The center is a locus, as shown by the heavy black line drawn from *A* to *C*.

It is not the compensating curve that insures balance. It is the facing of the guides and guidances toward the articulating center that assures balance.

The articulating center cannot possibly coincide with the center for the compensating curve if anatomic forms

of posterior teeth are used. Where anatomic forms of posterior teeth are used, the compensating curve bears no direct relation to the problems of articulation. (Fig. 15.)

Let us now consider the lateral articulating centers which are the controlling factors in arrangement of teeth for lateral balance. (Fig. 16.) The extensive ramifications of lateral articulating centers do not permit the inclusion of a discussion of these centers in this paper. However, a grasp of the articulating center for the centric-protrusive movement will assure one of results not otherwise obtainable. Those of you who are interested in delving deeper into the subject are referred to an essay by Sears.[10] It should be mentioned here that the basis of this presentation is the paper referred to and due credit must be given to Victor H. Sears of New York for the thorough investigation and advanced conclusions herein propounded.

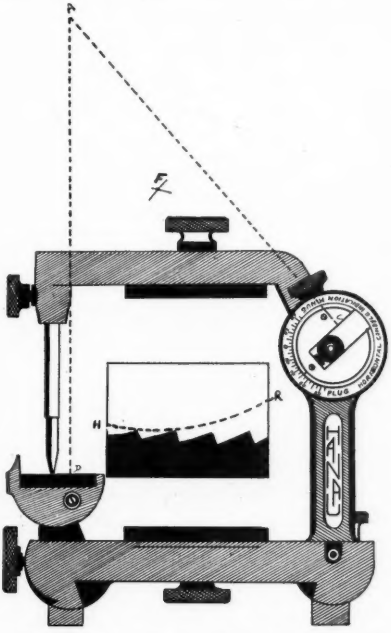

Fig. 13.—Graph showing that the compensating curve *HR* indicated for this case may be totally disregarded, yet balanced occlusion in the centric-protrusive movement will be obtained with a horizontal plane of orientation merely by facing the tooth guidances toward the protrusive articulating center *A*.

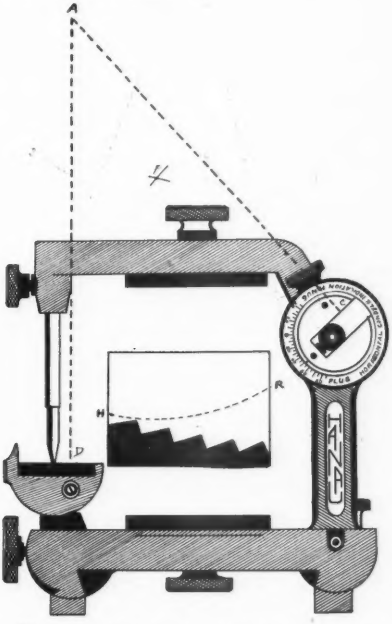

Fig. 14.—Graph showing that the steep compensating curve *HR* indicated for this case may be totally disregarded. The reverse curve will give balance in the protrusive-centric movement merely by facing the tooth guidances toward the protrusive articulating center *A*.

The newer conceptions of the problems of articulation have lead to the

10. Sears, V. H.: Some Fundamental Factors in Tooth Articulation, J. Dent. Res., 8:339 (June) 1928.

design of what are known as Sears' channel posterior teeth. These tooth forms are of zero buccal view cusp height and have as their aim the high degree of functional efficiency herein mentioned, plus the minimizing of trauma to the denture supporting tissues.

Each maxillary posterior tooth has a buccal and a lingual cusp. (Figs. 17-19.) There is a channel running along the occlusal surfaces in a mesiodistal direction between the buccal and lingual cusps, and on the buccal cusps are V-shaped elevations for cutting.

Each mandibular posterior tooth consists of but one cusp. (Fig. 20.) A buccal slope and a lingual slope meet to form a sharp crest in the center of the tooth. The crest runs in a mesial-distal direction.

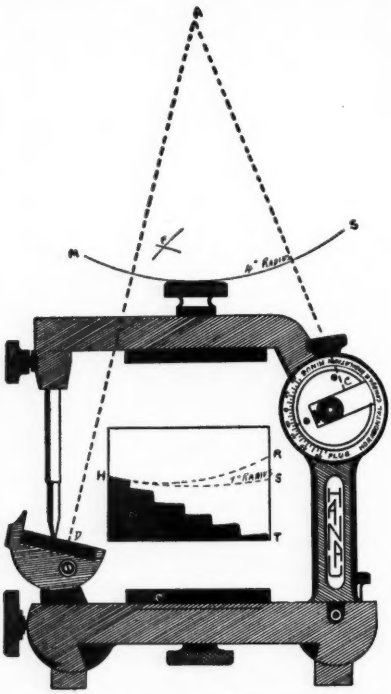

Fig. 15.—Graph in which arc *MS* was scribed with the protrusive articulating center *A* as a center and a 4-inch radius; arc *HS*, with the same center and a 7-inch radius, and the compensating curve *HR*, with *F* as a center. If a sphere is used with the articulating center *A* as a center, the sphere does not have to be of 4-inch radius. The compensating curve *HR* may also be disregarded and protrusive balance obtained by a reverse curve *HT*. Articulating center *A* does not and cannot coincide with center *F* of the compensating curve when anatomic forms of teeth are used.

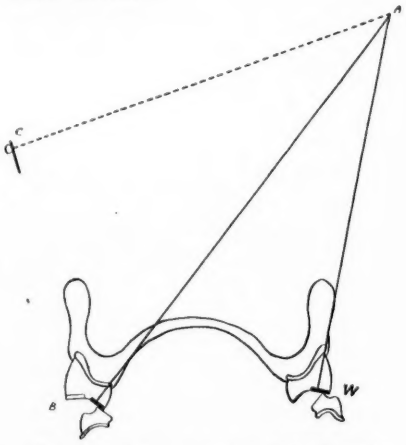

Fig. 16.—Graph showing lateral articulating center *A* obtained by the intersection of the perpendiculars erected upon the tooth guidances of the balancing and working sides (heavy black lines), and the condyle guide *C* of the balancing side. The balancing side is represented by *B*, and the working side by *W*.

When the teeth are arranged, the crests of the mandibular teeth are set over the center of the mandibular ridge (Fig. 21) and faced toward the protrusive articulating center, due consideration being given to the plane of orientation. Since the mandibular teeth are of zero buccal view cusp height, they conform readily to the movement

established by the guides. The maxillary teeth are arranged so that the centers of the channels are in contact with the crests of the mandibular teeth and protrusive and lateral balance are established.

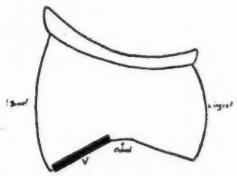

Fig. 17.—Maxillary channel tooth as viewed from the mesial aspect showing the channel separating the buccal from the lingual cusp, and the V-shaped saw blade on the buccal cusp.

The effect of the channel and crest arrangement is the minimizing of the dislodging forces in the centric-protrusive movement because of the free mesial-distal gliding tooth surfaces. The channel permits further a limited lateral freedom of movement without lock. The tooth forms allow both the maxillary and mandibular occlusal surfaces

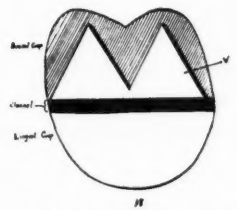

Fig. 18.—Occlusal view of maxillary channel posterior tooth showing the channel separating the buccal from the lingual cusp and V-shaped elevations on the buccal cusps.

to be set in the line of force to be directed against the corresponding ridge crests in accordance with the principles that we have already considered. From the buccal aspect, the cusp surfaces permit an arrangement whereby they may be placed parallel with the supporting ridge as demanded by good mechanical principles.

The forms of the mandibular teeth allow more tongue room, and because of the shape of the teeth, the tongue

Fig. 19.—Buccal view of maxillary molar channel tooth.

has a retaining influence on the mandibular denture. Teeth of this kind can be arranged farther toward the lingual side of the ridge than could be done with the teeth having both lingual and buccal cusps. (Fig. 22.)

These teeth are revolutionary in form and eliminate many problems in tooth articulation. Therefore, their use is advocated. I have observed more than 2,000 cases in which channel pos-

Fig. 20.—Mandibular channel tooth showing buccal and lingual slopes and plateau. After milling, this flat plateau is cut to make a sharp crest.

terior teeth have been used, and I am glad to say, from the gratifying results obtained, that their design, together with the sound mechanical principles of tooth arrangement with which they are identified, has firmly established in my

mind the correctness of the underlying principles.

Those pioneers in denture prosthesis who have given their time and effort to advance prosthetic dentistry should be most respectfully regarded whether their findings are still acceptable or whether their conceptions have been relegated to the past. Through their research, they laid the foundations for our present knowledge and future learning.

The last word in denture construction has not been spoken. It has been my pleasure to indicate to you some recent important contributions in the field of tooth design and tooth arrangement. The future will bring further advances. And when they come, we shall welcome them.

333 Fairmount Ave.

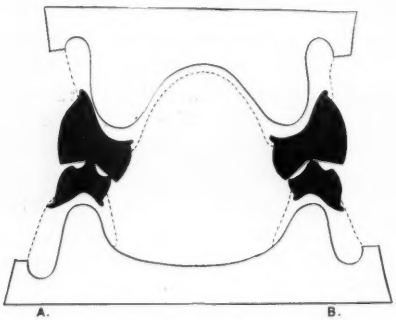

Fig. 21.—*A:* Before milling. The channel teeth are set in centric occlusion. The plateaus of the mandibular teeth are placed over the crest of the mandibular ridge and faced toward the articulating center. There is contact with the maxillary teeth on the lingual cusps and plateaus filling the channel, but no contact on the buccal side. *B:* After milling. The channel teeth are in centric occlusion. The plateaus of the mandibular teeth have been cut to form a sharp crest which touches the maxillary teeth only in the middle of the channel. The lingual slopes of the mandibular teeth have also been cut. There is no contact on the buccal or lingual sides.

DISCUSSION

H. B. Washburn, St. Paul, Minn.: After careful study of the paper which has been presented by Dr. Schwartz, I must express the opinion that the subject needs more amplification in order to be understood. The fact that the idea is new and, generally speaking, untried is apt to cause many to condemn it as impracticable. Such a situation too often occurs, and is to be deplored for the simple reason that one should try to put the technic into practice and observe the actual results before rendering an opinion. One of the greatest barriers to progress in dentistry is the difficulty we have in getting dentists, after any plan has been presented, to go back to their offices and carefully carry out the technic of the new plan over and over again, until they have first hand knowledge of results. This point cannot be stressed too forcibly, and I recommend the adoption and use in our practices of Dr. Sears' center for setting up artificial teeth, anticipating that if we do this, we shall have accomplished two things. We shall have a better understanding of Dr. Sear's proposition and know whether or not it has any merit, and we shall have extended our knowledge concerning occlusion. There are two points in this paper that I would like particularly to call your attention to. It is gratifying to many of us to observe the trend each year toward finding

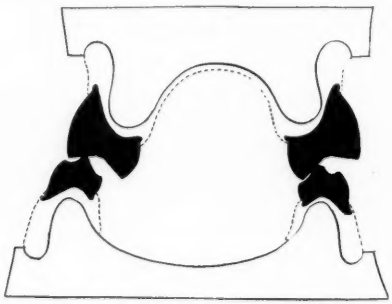

Fig. 22.—Lateral balance after milling; channel posterior teeth. Left: Working side. Right: Balancing side.

a center of occlusion. This can mean only one thing, namely, that some day some one will find the correct center, which may or may not coincide with the center first described by George S. Monson in 1898, and which is still used by him and his students. The second thought I desire to stress naturally follows because we who have been using the Monson center believe as does Dr. Sears that the closer we can direct the forces of occlusion at right angles to the seating area of the dentures through the proper setting up of the teeth, the more stable and generally successful the dentures will be. It becomes necessary, you see, actually to put these ideas into practice so that we may be able to know how best to obtain this much desired result. We of the Monson school believe that we have been obtaining just what Dr. Sears is striving for as expressed in this paper by Dr. Schwartz. Dr. Sears evidently does not believe the center as advocated by Dr. Monson will produce dentures with the driving forces of occlusion in a correct direction, and so he comes to us with his plan of setting the occlusion to a center which depends on the contour of the ridges at the particular time the dentures are to be made. I hope you see the point now that I made in the beginning. Here we have each year new ideas presented to us, but how many of us go home and try to follow out the technic faithfully and long enough to obtain a clean understanding of the merits of each? If we have been doing so each year, we should be able to judge in fairness and not as is so often done, without actual trial.

F. M. Hight, Houston, Texas: It is rather hard to understand just what is meant in this paper. How do you determine the incisal angle? What arrangement do you have of the anterior teeth?

A. Y. Russell, Baltimore, Md.: I would like to ask Dr. Schwartz how he obtains the center.

Dr. Schwartz (closing): I want to thank Dr. Washburn because he recommended that each of you test the principles outlined in the essay. Proper test of theories is to be encouraged. However, Dr. Washburn inferred that the tests should be made because the principles presented have not been tried out. This conception is erroneous. The principles have been tried out and have proved themselves of such merit as to warrant their presentation to the profession. Dr. Sears has used the procedures outlined for seven years, I have used them for three years, and many outstanding prosthetists have used them for varying periods of time in various sections of the country, with excellent results. At New York University, the students have been using the principles mentioned ever since Dr. Sears has been the head of the prosthetic department there. Last year, it was my privilege, at that institution, to observe more than 2,000 cases of full dentures using these principles, and almost as many partial dentures, with results amazingly gratifying. Notwithstanding all these tests, it would be a pleasure to learn what results you obtain when you apply these principles at your offices. Dr. Washburn stated that perhaps some day we shall find the "correct" center. He infers that one ideal center will do. The "ideal center" is the basis of the spherical theory. Dr. Monson is to be commended for having discovered so beautiful a theory, but a close reading of the paper presented by me today will disclose that a single center cannot and will not do unless flat cusps are used. The moment cusp height is introduced, even in the slightest degree, we must have a number of articulating centers; namely, protrusive, and right and left lateral. Dr. Washburn stated that the forces of occlusion are directed in approximately the same direction in using the principles herein outlined as they are directed when using the spherical curve. This is an error. If we study the forces of occlusion, we find that there has been a general misconception as to the direction of the forces in the centric-protrusive movement. In none of the literature have I found a correct interpretation of these forces. The generally accepted notion has been that, with anatomic forms of teeth, the forces of occlusion in the centric-protrusive movement are in line with the long axes of the teeth. Those of the Monson school appear to have accepted this idea too, and they have set the teeth with the long axes facing the center of the sphere. To correct the general belief, we must state that, with anatomic forms of teeth, the forces of occlusion in the centric-protrusive movement are not directed in line with the long axes of the teeth, but are directed against the mesial inclined planes of the mandibular bicuspids and molars and the distal inclined planes of the maxillary bicuspids and molars. With such knowledge, we know that the forces of

occlusion, in the movement mentioned, cannot be in line with the long axes of the teeth unless the teeth are of zero buccal-view cusp height. The misconception of the direction of the force has been one of the chief causes for the dislodgment of dentures, even when the spherical curve was used. With channel posterior teeth and the principles herein stated, it is possible to direct the forces in line with the long axes of the teeth and at the same time direct the forces at right angles to the ridges, thereby minimizing the dislodging forces and establishing greater stability of the denture bases. Channel teeth can be used with any technic, whether it be straight line, Gysi, Wadsworth, Monson, Hanau or what not. However, the best results will be obtained if there are associated with these teeth the fundamentals of tooth arrangement here advocated. Now to answer Dr. Hight: "How do we determine the incisal angle?" The answer to this will also answer Dr. Russell. Figure 6 demonstrates the procedure. Erect a perpendicular upon the area of greatest support of the mandibular ridge, and also one upon the condyle indication. Their intersection determines the "protrusive articulating center." Next, face the incisal guide in such position that a perpendicular from it will also pass through the same protrusive articulating center. Dr. Hight's second question concerns the effect of the negative incisal guide on the arrangement of the anterior teeth. Its effect is such as to give a large horizontal overbite (overjet) and a shallow vertical overbite, a very desirable arrangement for denture stability.

THE RELATION OF THE GENERAL PRACTITIONER TO PERIODONTIA*

By A. W. BRYAN, D.D.S., F.A.C.D., Iowa City, Iowa

IN a discussion of the relation of the general practitioner to periodontia. it seems logical to consider the subject from two standpoints: his relation to prevention and to therapeutics. It is a well-known fact that the dental practitioner occupies an important position in relation to the health of his patients in recognizing, in their very earliest stages, malignant growths or benign ones which tend to become malignant. The dentist sees these conditions long before the medical man would, and thus is in a position to advise early examination and treatment. This means great benefit to the patient, perhaps even the conservation of his life. The general practitioner's relation to periodontia is not so vastly different from this. He sees patients early and at regular intervals throughout life. By periodical, methodical examinations, he should recognize the very earliest symptoms of inflammatory changes in the periodontal tissues, and if he does not care to treat them, can refer the patients to some one doing that work.

With the foregoing facts admitted, we can state as the premise to this paper that the general practitioner has a very definite relation to and a very serious responsibility in the consideration of periodontia.

*Read before the Section on Orthodontia and Periodontia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

*The papers of Drs. Bryan, Hartzell, Hirschfeld, Leonard and Ward were presented as a symposium on "Periodontia for the General Practitioner."

Patients with mouth tissues absolutely normal as to color, tone and contour are few. In fact, so seldom is normal color and tone of gingival tissues encountered that we have almost come to consider slight hyperemia as a matter of course. In an observation of hundreds of cases yearly in an infirmary, very few are seen that do not have mild inflammatory conditions at least in the marginal gingivae; yet many of these patients would not be warned, during the course of an oral examination, that there was any trouble of this nature. G. V. Black, in his book "Special Dental Pathology," in discussing diseases of the investing tissues, says, "The insidiousness of this class of disease is such that not many, even dentists, have been regularly in the habit of noticing them during their early stages. A little redness here or there seems to be of no consequence, and, after a time, when the case has gone too far for remedies to be effective, the dentist will find the disease very serious, and incorrectly suppose that it is comparatively recent in its beginning." In another chapter, he says, "This requires of the dentist that he make careful examination of the gingivae of every patient, and, if there are inflammations, they should have immediate and most painstaking treatment. No matter what may be the cause of such inflammation, it should be searched out to the limit, found and removed. In this way, I am persuaded from past experience that the vast majority of these cases can be prevented by removing the danger in its inception." Thus does Dr. Black clearly define the responsibility of the general practitioner in the matter of careful examination and early recognition of periodontal disease, and his ability to prevent more serious involvements by this early recognition and removal of cause.

When a dentist accepts a patient, he assumes a definite responsibility. That responsibility not only involves the search for pathologic processes in the hard structures and the repair of the defects caused by such processes, but includes also a painstaking observation of the supporting tissues of the teeth in an effort to discern the slightest variance from normal. The patient came to the dentist to learn whether the mouth tissues were healthy, not simply to see if there were any cavities in the teeth. He expects at least a warning if the soft tissues are not healthy, and if the dentist overlooks the slightest hyperemia of the marginal gingivae or congestion of the pericemental membrane, or considers such changes too slight for treatment, the patient spans the interval until the next visit with a false sense of security as to oral health.

Members of the profession who are connected with infirmaries in dental schools see many patients with advanced, serious lesions of the periodontal tissues who say that they have had frequent examinations and have never even been warned that there was any trouble with the oral soft tissues. Carious areas have been searched for diligently and attended to, but the real foundation of oral health has been neglected in the examination. A tooth saved from destruction by dental caries is only half saved if it is allowed to be lost prematurely because of neglect of its supporting tissues.

It seems logical to assume that the tendency on the part of so many of the profession to be careless in observing the health of the soft tissues may be due to the fact that periodontia, until recent years, has been a sadly neglected subject in dental curriculums. With the growing tendency to emphasis by the dental schools in the study and treatment of periodontal diseases, there should be a

decided benefit to the public from more careful consideration of this phase of practice. This benefit will be the result not only of the added attention given to these diseases by recent and future graduates, but also of the appearance in the dental literature of more material dealing with this phase of dentistry. The foregoing statements are intended in no way to cast reflections on the older practitioners who are dealing successfully with these problems, but are rather to show the hopeful outlook because of more intensive work along these lines in the training of dental students.

There is another phase of the prevention of periodontal disease with which the general practitioner is very definitely related. Again quoting G. V. Black's "Special Dental Pathology": "Effective prophylaxis against the diseases of the investing tissues cannot result from the so-called oral prophylaxis treatments; this must be brought about by the practice of prophylactic dentistry, in which the effect of every operation in preventing or causing disease will be appreciated." This principle is just as important today as when Dr. Black wrote it. The amount of periodontal disease which is due to careless operating, unrestored contacts, fillings with some aspect of anatomic tooth form neglected, misfitting appliances, etc., is tremendous. Here it is that the general practitioner occupies the key position as regards true prevention. The importance of tooth form as related to the health of the supporting tissues has been vividly presented by Prime and others. Let the practitioner not only watch diligently for beginning disease but also see to it that he himself does not bring about conditions favorable to its inception.

Let us consider the problem of the general practitioner from the standpoint of therapeutics in periodontal disease. While we now believe that some of these periodontal lesions have their beginning in tissues other than marginal gingiva, the fact is evident that a large majority of the cases begin at this location, with local irritation as a primary factor. These incipient cases can and should be handled by the general practitioner. As Dr. Black stated, a careful searching out and removal of these irritating factors will prevent serious involvement of the deeper tissues. The vast majority of serious cases would never develop if they had early diagnosis.

Without intention of discussing the technic of treatment, it seems fitting, in a paper of this kind, to consider briefly the tendency on the part of so many of the profession to practice empiric rather than rational therapeutics. Every year, we find an increase in the number of proprietary preparations appearing on the market for the treatment of periodontal disease. Some are advertised directly to the public, while others are promoted with an insidious type of advertising, using the dentist as a "middle-man." I have in mind a preparation that has recently appeared, selling for $2 a package, the container stating that the patient, in the event that he has pyorrhea, should go to the dentist and have him treat it the "———" way. Also, if he, the dentist, does not know how, they, the company, will be glad to tell him, if he will write. What a tribute to the dentist in his knowledge of materia medica and therapeutics! We must realize as practitioners that treatment of periodontal disease is no different in principle than the treatment of any other disease, all rational therapeutics being based, first, on removal of cause and, secondly, on the use of agents the actions of which are known. The general practitioner can do much to

put the treatment of periodontal disease on a rational basis.

We have endeavored to show that the general practitioner bears a relationship to periodontia in several ways. First, he sees the mouths of the younger patients, and, by careful, painstaking examination, is able to detect the very earliest symptoms of trouble and remove the causes. He thus assumes his responsibility in the prevention of serious cases. Secondly, he has a definite responsibility in the performance of his restorative work, in seeing to it that fillings, crowns, bridges and other appliances are constructed with anatomic form and on correct mechanical principles, to avoid injury to the soft tissues and supporting alveolar process. This is true prevention. Thirdly, he can and should treat many of the incipient and milder cases. As many patients do not have access to the specialist, the general practitioner must assume this responsibility. Furthermore, many patients prefer to have as much of their work as possible done by their regular dentist and will neglect seeking attention if referred to another dentist.

It seems that this one fact stands out clearly: The health of the oral tissues of the general public lies to a great extent with the general practitioner. It is he who sees these patients first, and, whether he treats them or refers them to another dentist, he has a tremendous responsibility in recognizing the first changes from normality in these structures and in warning patients of danger. If the dental profession is to fill successfully the position that they have been called on to take in the program of health service, the general practitioner must recognize and assume this responsibility.

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THE PREDISPOSING CAUSES OF PYORRHEA ALVEOLARIS*

By THOMAS B. HARTZELL, M.D., D.M.D., F.A.C.D., Minneapolis, Minn.

PYORRHEA is caused by pyogenic cocci, and but for them it could not exist. Therefore, the predisposing causes of pyorrhea are identical with the predisposing causes of infection by any of the infective micro-organisms.

These predisposing causes may be divided into constitutional and local predisposition, or we might say general and special causes. Among the constitutional or general causes, we may list all those factors that tend to break down or reduce the body's power to oppose bacterial invasion. Overwork; indigestion; worry; overfeeding; starvation; too little water (8 ounces should be taken for every 10 pounds of body weight every twenty-four hours, to enable the blood to carry food to tissues; to eliminate waste and also to maintain a sufficient bulk of blood to keep the vascular system full); unsuitable and imperfect food; constipation; lack of exercise; the breathing of impure air; imperfect elim-

*Read before the Section on Orthodontia and Periodontia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

ination by skin, kidneys or lungs; these are some of the many common things that predispose to disease in general, and bacterial disease in particular.

It is conceivable that our bodies could be so perfectly nourished that infective micro-organisms, even though admitted in air, foods or water, could not grow; in other words, that we could have and maintain a perfect immunity to them, thus making pyorrhea impossible. This, of course, would not include periodontoclasia induced by either traumatic occlusion or malocclusion, a nonbacterial thing, which may be classed with the special or local predisposing causes of pyorrhea, because traumatic occlusion or malocclusion induces congestion and initiates osteoclasis, slowing blood movement, thus reducing to some degree the power of the tissues to protect themselves and also reducing the number of leukocytes in the tissue area infected, all of which favors rapid bacterial growth, which with pyogenic cocci may be so fast as to double their number every thirty-five minutes.

Traumatic occlusion can and does induce osteoclasis (without the presence of infection) by the action of the same principle utilized by the orthodontist, namely, pressure, either intermittent or continuous, and by reason of this fact is often wrongly cited as an actual cause of pyorrhea.

It is a fact that traumatic osteoclasis, combined with entry of bacteria into and their action in the tissues around the teeth, will cause a more rapid loss of bone than will either traumatic occlusion alone or infection alone, and a periodontoclasia in which both exist presents a greater problem to the practitioner than either of them alone. The local conditions in the mouth which favor invasion of the tissues surrounding the teeth are, first, broken immunity with habitual uncleanliness of teeth and the continuous introduction of a new supply of pyogenic bacteria into the mouth in foods, liquids and air. For example, I have examined milk which contained 1,000,000 bacteria to the centimeter, a large proportion of which were pus producers. All exposed foods are bacteria laden.

The position of the teeth themselves often predisposes them and their surrounding tissues to infection, because irregular, ill-positioned teeth lose the advantage of the cleansing action of the chewing of foods, and large numbers of bacteria accumulate on them which are most difficult of removal, even by vigorous cleansing. For the same reason, disuse of a tooth, so placed that it cannot work, predisposes it and its surrounding tissues to infection, and disuse also predisposes to infection of its surrounding tissue, because disused teeth fail to receive the stimulation of exercise which, in vigorous chewing, should require the expenditure, according to Black, of not less than 1,700 pounds a day, and I am convinced that in many persons may go as high as 5,000 pounds in the work of a day's mastication. This means a vigorous circulation of blood in the tissues local to the teeth. Lack of exercise is therefore a most important predisposition, and lack of properly directed mouth and tooth hygiene, a hygiene which has for its purpose the removal and detoxification of the bacterial growth of the day so accurately that, after the exercise of such hygienic measures, the application of revealing stain discloses nothing to the eye.

We must remember that Kligler found that a single milligram of material scraped from what he considered a clean tooth contained 9,000,000 bacteria, and on dirty, unclean teeth he found as much as 900,000,000 germs in a milligram of

tooth scrapings. Keep in mind that these germs grow with tremendous speed. Pyogenic cocci are born by fission, and are therefore adult individuals from their beginning. Also remember that they do not, as a rule, grow old and die, but at the end of thirty-five minutes, a generation of toxin and ferment producing germs becomes two new generations of vigorous individuals, ready to attack the tissues through the medium of their digestive ferment. Other predisposing causes to pyorrhea are roughened surfaces near the gum margin, because they enable greater numbers of bacteria to lodge near the tissues than if the surfaces were smooth. Roughened surfaces are not easily cleaned, enough bacteria remaining in the depressions to perpetuate the disease in spite of all efforts at cleansing. Any and all imperfections of tooth surface, for the reasons given above, help to afford bacterial growths safe lodgment for their destructive organisms. Hence, the great importance now attached by periodontists to gaining and maintaining a high polish on tooth necks and tooth surfaces, to make the daily cleansing easy for the patient.

There probably are many more both constitutional and local predisposing causes to pyorrhea, but I have indicated a sufficient number of both to help the student to understand the problem.

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VINCENT'S INFECTION: CAUSE AND TREATMENT*

By ISADOR HIRSCHFELD, D.D.S., New York City

THE incidence of Vincent's infection of the mouth as an epidemic during the World War, and the large number of cases occurring since then, have given impetus to, and ample opportunity for, a study of the disease and its treatment. Great progress has been made, but much has yet to be learned.

There seems to be a difference of opinion as to the present rate of increase in the number of cases of Vincent's infection. Some believe that the infection is not spreading appreciably, but that the number of new cases only seems to be greater because (1) dentists have learned to diagnose this disease more readily; (2) many war and postwar cases, not completely cured, recur from time to time, and (3) many cases that would heretofore have passed unnoticed are now brought to the attention of the dentist by patients themselves, who, having been effectively warned by advertisements of dentifrice manufacturers to beware of "spongy, bleeding gums," seek relief immediately after the first symptoms appear.

The general opinion seems to be that there is a progressive increase, and this may be accounted for in several ways. As this disease is contagious, the supposed increase, in the past few years, in kissing habits among young folks may be a logical reason. One of many corroborating instances of this is the statement by a recent writer that four out of six young

*Read before the Section on Orthodontia and Periodontia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

women who had participated in kissing games at a party came to him soon after for treatment of Vincent's infection.

Another reason may be the present widespread habit of cigaret smoking, which, in certain mouths, has a deleterious effect on the tissues, thereby lowering resistance and so predisposing to disease. Of extreme interest regarding the possible relationship between this disease and smoking are the following figures furnished by the office of the Commissioner of Internal Revenue[1] concerning the use of cigarets in the United States, as based on the sale of stamps. In round numbers, they are: 1910, 7,000,000,000; 1920, 53,000,000,000; 1927, 93,000,000,000. This remarkable jump is almost entirely due to an increase in home consumption as there has been no material corresponding increase in the export of cigarets during that time.

It is a noteworthy fact also that, although formerly Vincent's infection was not commonly found in women, such cases are now quite frequent, since smoking has become vogue among them. Furthermore, that smoking is a potent factor in this disease I especially infer from my observations that certain cases which stubbornly resisted treatment reacted remarkably on cessation of smoking, although the routine treatment remained unchanged, and that, in other instances, there was a noticeable retrogression when patients returned to smoking too soon.

Fig. 1.—Case of acute Vincent's infection before beginning of treatment. Note the necrotic interproximal papillae, especially in the lower arch, and the serpiginous grey necrotic line. Beyond it, the gum is highly inflamed. There is marked hemorrhage, especially on the left side. A continuous stream is shown running down from between the lower left lateral incisor and cuspid. The gums were very tender. The patient was depressed and the temperature was 101 F.

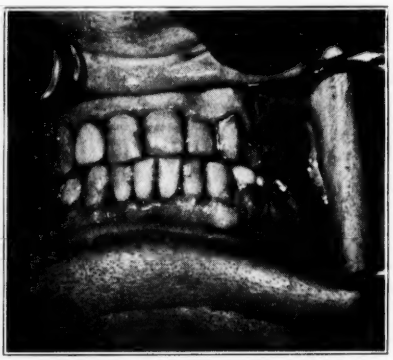

Fig. 2.—Mouth shown in Figure 1, twenty-four hours after beginning of treatment. After the wiping away of the necrotic tissue, the typical interproximal destruction is very evident. While there is no recurrence of necrosis of tissue, the hemorrhage is very greatly reduced and the gums less tender. They are still quite inflamed, especially about the lower incisors.

The foregoing statements must not be construed to indicate that the disease does not occur frequently in nonsmokers. There are, of course, other factors that play an important part in predisposing the mouth to the disease. Generally

1. Personal communication.

speaking, they include conditions which induce either a local or systemic lowered resistance.

ETIOLOGY

In addition to the virulence of the Vincent micro-organisms, the other factors required for the establishment of the infection seem to be a coincidental general lowered resistance plus a suitable local soil in which these microbes may gain a foothold. Close observation in practically all cases of Vincent's infection will disclose the fact that, primarily, these organisms attack, spread from and are most devastating in those areas of the soft tissues in which circulation has been previously impaired by mechanical, chemical or bacterial trauma.

It will also be found that these foci are so situated that the bacteria are protected from the cleansing action of mastication and from haphazard tooth brushing. The following may be such locations: the flap of gingiva partly covering the lower third molar; the acute angle formed by a sharply inclined drifting tooth; the interproximal gingivae where teeth overlap and form emphasized embrasures; the buccal gingival margins of second and third upper molars, the lingual gingival margins of second and third lower molars, especially near cer-

Fig. 3.—A case twenty-four hours after first treatment. Here, the gingival margins were not affected, the destructive process being confined to the interdental tissues only, where the characteristic punched out appearance may be noted. This picture of Vincent's infection has been seen much more frequently by the author in recent years than the one previously described (Fig. 1.), involving the entire marginal gingiva. During and for a short period after the World War, the extent of destruction was frequently still greater. Between the upper central incisors may still be seen a slightly necrotic border, separated from the normal gum by a bright red area of demarcation.

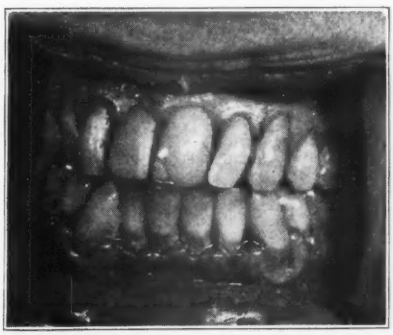

Fig. 4.—A case of subacute Vincent's infection of at least two years' duration. No necrotic tissue was ever noticed and the gums were never quite so tender as in the acute cases. They bled freely on slightest provocation and the interproximal tissue was especially affected. Note the highly inflamed and hypertrophic appearance of the receded papillae in the lower jaw, and especially the stubbed appearance of some of them. This is very frequently to be seen in the subacute type. In the upper jaw, the inflammation is not so marked, but the papillae are receded and bleed easily. In addition, deep pockets may be found beneath them either with or without macroscopic pus formation. The marginal gingival tissues, especially on the left side, are practically unaffected.

vical cavities in these regions, and on the mucous membrane of the cheeks or tongue or floor of the mouth immediately adjacent to these points; near the overhanging margins of faulty dental restorations; the gingivae covering teeth which are either in marked traumatic occlusion or in infraclusion; palatal margins near the anterior teeth where the gingivae are constantly inflamed by mouth breathing or by excessive smoking, especially of cigarets, and preexisting deep subgingival crevices.

Fig. 5.—A case of acute Vincent's infection, three days after beginning treatment. Contrary to the usual state of affairs, the papillae are very much hypertrophied, while the necrosis of the tissue originally seen was very slight. This case is of special interest, because the vertical ulcer right on the frenum and another one on the palate opposite the right lateral incisor showed no inclination to heal at the same rate of speed as the rest of the mouth. The Wassermann test reaction was four plus. These lesions healed readily under a routine course of treatment for syphilis.

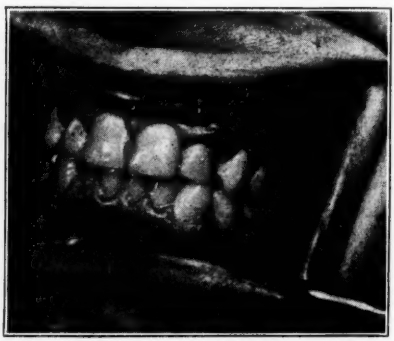

Fig. 6.—A case of acute Vincent's infection in which the dentist, unaware of the nature of the disease, insisted on vigorous gum brushing. Accordingly, necrotic patches developed on the alveolar gingivae over the upper left side from cuspid to molar, and similar lesions on the right side over the cuspid and bicuspids. This picture is shown to emphasize the importance of temporary discontinuation of brushing during the acute stage. A fair state of hygiene may be maintained by frequent rinsing with the prescribed mouth wash.

MECHANICAL TRAUMA AND BACTERIAL VIRULENCE

That mechanical trauma will light up bacterial virulence in latent or subacute infection is frequently demonstrated in this disease. A patient's teeth are thoroughly scaled, and within from twenty-four to thirty-six hours, he develops all the earmarks of an acute Vincent infection; so, also, immediately after the extraction of a tooth, more particularly a third molar, very often the site of the primary infection. Here, the acute stage flares up not only in the immediate vicinity of the extraction, but also in various parts of the mouth. Inquiry in such instances often brings out a suggestion of the existence of subacute or chronic infection prior to the trauma. That this should happen is not surprising, as it is a known fact that many mouths with no clinical symptoms of Vincent's infection are hosts to great numbers of both Vin-

cent spirochetes and fusiform bacilli.[2] For this reason, Dr. Bloodgood, of Johns Hopkins University Medical School,[3] rightly suggests that dentists employ sodium perborate in every patient's mouth "preliminary to any dental operation, including the cleansing of teeth."

I feel convinced that it is advisable for the physician also to prepare both the throat and the mouth against Vincent infection, preliminary to any throat operation. My reasons are that (1) quite frequently, a tonsillectomy is followed immediately, not only by a Vincent's angina (in the throat) but also by a spreading of the acute condition to the mouth, and (2) an analysis of the answers to a questionnaire I recently sent to a group of otolaryngologists indicates strongly that the focus of infection of the disease, both in the throat and in the mouth, is very frequently, if not always, the dental arch. This is further corroborated by the fact that, while the periodontist rarely sees the throat involved in the comparatively numerous cases he treats, many throat specialists agree on a large percentage of mouth involvements in throat infections. Therefore, it might be well for the surgeon to look to the mouth as well as to the throat as a precaution against Vincent's infection prior to a throat operation. A résumé of the findings in the questionnaire will be given fully in a paper now in process of preparation.

SYSTEMIC FACTORS

A general run-down condition may invite the infection. This is evidenced by the frequency with which it occurs after a protracted period of mental or physical strain, or as an aftermath of influenza or other bed-confining illnesses. The dietetic element is given as a factor for serious consideration by some recent writers in Europe and in this country,[4] who consider that Vincent's infection is caused essentially by an avitaminosis (scurvy). While corrective diet may prove helpful in some stubborn cases, I believe that, with but few exceptions, diet deficiency should not be considered the underlying cause, for the reasons that local treatment alone usually clears up the condition very rapidly, and a survey of case histories indicates that most patients partake sufficiently of the antiscorbutic vitamin.

The possibility that syphilis, like other diseases, may predispose to this infection should always be considered in stubborn cases. Indeed, when the two are found at the same time, it is often necessary to treat the syphilis before the Vincent's infection will react fully to local treatment. Although each of these is identified with spirochetes, the organisms are different, and Wassermann tests have shown again and again that one has no relation to the other.

TREATMENT

From the very beginning, treatment must be carried on with a determination by the operator and the patient to stamp out the infection as quickly and as thoroughly as possible. Haphazard treatment may change the prognosis from very good to doubtful, or even serious, termination. The underlying principles upon which proper treatment is based are (1) the elimination of the bacterial element; (2) the raising of the general resistance;

2. Hirschfeld, Isador: Vincent's Infection of the Mouth, New York M. J., 118:150 (Aug. 1) 1923.

3. Bloodgood, J. C.: Oral Lesions Due to Vincent's Angina, J. A. M. A., 88:1142 (April 9) 1927.

4. Prinz, Hermann: Dental Cosmos, 69:53 (Jan.) 1927.

(3) the removal of the traumatizing agencies which tend to lower the local resistance, and (4) the promotion of local immunization, to ward off reinfection.

Briefly, the treatment is as follows: All the necrotic gingival tissue and food detritus are thoroughly but gently wiped out with the cotton wrapped end of a round toothpick (not an applicator) dipped in a 10 per cent solution of neoarsphenamin in glycerin. This is best accomplished by a short twist of the toothpick, which, at the same time, deposits the drug.

During this process, the patient is permitted to expectorate as frequently as desired, but not to rinse until about ten minutes after the treatment. He is directed to obtain an original 1-pound package of sodium perborate with which to make a mouthwash—one teaspoonful to three-fourths of a glass of warm water, to be used every half hour until otherwise instructed, rinsing the mouth thoroughly with the entire contents each time, forcing it between the teeth. The patient is advised to take a cathartic at once; to use a light, corrective diet; to rest as much as possible, and, if necessary, to stay home from work. Smoking is prohibited temporarily, or at least reduced to a minimum. A ban is placed on spicy food and alcohol.

Almost without exception, the patient returns the next day much relieved physically and happier. The necrotic tissue is reduced or entirely eliminated, and the hemorrhage and pain are greatly lessened, even though the gingival inflammation may still be strongly in evidence. If these improvements are not very marked within from twenty-four to forty-eight hours, the probabilities are that either the directions were not followed faithfully or that the diagnosis was incorrect. In the latter event, valuable time should not be lost through continued treatment for Vincent's infection, as the condition remains unchecked and is allowed to progress. Another diagnosis is made necessary and treatment instituted accordingly.

At the second visit, the topical application is repeated; and at the third, all gross deposits of calculus are gently removed. The patient may then reduce the rinsing to one or two hour intervals, according to the degree of improvement. Toothbrushing is contraindicated from the very beginning, but the teeth are kept fairly clean by the frequent rinsing, and partly by the gentle use of a swab of cotton dipped in the perborate solution. The topical applications are repeated daily, and about ten days after commencement of treatment, it is usually advisable to remove all local traumatizing agents.

Brushing is commenced as soon as the gingivitis has about disappeared and a final, thorough scaling of the subgingival root surfaces, especially interproximally, is carried out. The patient is taught proper tooth brushing, and he must be made to realize the great importance of doing it thoroughly, particularly in the interdental spaces. The visits are now reduced to about two a week for two weeks, and after that, only occasional visits for follow-up observation. These examinations discourage a return to habits of improper hygiene and infrafunction, which may be responsible for an avoidable reinfection. Use of the mouth wash is continued for approximately two months, in conjunction with the use of the toothbrush dipped in it, about twice daily, as another measure against reinfection. All surgical operations, such as tooth extractions, should

be postponed until after the complete elimination of the infection. And last, but not least, the patient must be informed, at the very first visit, that the disease is highly contagious and that he must take every precaution against spreading the infection.

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PERIODONTOCLASIA: CAUSE AND TREATMENT*

By HAROLD J. LEONARD, D.D.S., B.A., New York City

THE treatment of periodontoclasia is one of the most satisfactory phases of dental practice, being definite, with results nearly always certain and effects so pleasing to both patient and operator that they are a source of gratification. Furthermore, the treatment is comparatively simple, and, in the large majority of teeth which should be saved at all, is not beyond the skill of the dentist in general practice.

For treatment to be definite and results certain, it is absolutely necessary to understand what periodontoclasia is and how it is caused. It is not a contagious disease of special bacterial type conveyed by one person to another. It is a slow breaking down of investing tissues of the teeth which may be brought about by one or more of three main conditions, working alone or together. These conditions are (1) excessive bacterial accumulation on the teeth; (2) mechanical injury operating over a long period, and (3) impaired nutrition of the tissue cells of the gingival and periodontal structures.

Pus may or may not be present in periodontoclasia. When present, it is merely a symptom of the breaking down of the process going on underneath. Bacterial accumulations on the teeth occur from lack of mouth care and overeating. When the meal is considerably in excess of body requirements, the saliva, after the meal, becomes overloaded with material that is deposited on the teeth and tongue, giving a furry feeling to the teeth, a bad taste to the mouth and a bad odor to the breath. This material soon breaks down into a bacterial mass which, lying against the gingiva, causes slow inflammation and invasion of this tissue. The point of greatest penetration is at the base of the gingival crevice at the line of attachment. The final effect of this bacterial invasion is a softening of all the fibers of the gingiva and gingival pericementum, with gradual solution of the attaching fibers leading to a deepening of the gingival crevice and pocket formation. Lime, deposited at the time of the initial salivary deposit or afterwards in the bacterial growth, gradually forms a mass of calculus above the gingival margin. Lymph and blood oozing from the inflamed surface of the gingival crevice desposit lime in the same way beneath the gingiva to form the serumal calculus.

Excessive bacterial growth on the teeth is not the result of overeating or a poorly balanced diet alone. Once the periodontal tissues are inflamed and oozing, the

*Read before the Section on Orthodontia and Periodontia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

exudate itself will be a source of bacterial growth on the teeth. There are great variations between individuals in the tendency to soft accretions, bacterial growth and calculus on the teeth. Whatever the cause of the bacterial growth, the effect is a tendency to bacterial penetration, chronic inflammation and slow pocket formation.

Mechanical injury leading to periodontoclasia may be due to the type of food impinging in areas of faulty contact, but a far more important and common cause is a faulty adjustment of the cusps of the teeth to the movements of the mandible. By this faulty adjustment, the cusps interfere with the mandibular movements, thereby subjecting the tooth to great stress. The tooth is moved bodily in excess of its normal range, with the result that bone absorption occurs to give room, and degenerative changes occur in the pericementum or pericemental membrane. The injury thus given to the periodontal tissues renders them very susceptible to the bacterial invasion, with the result that deep pockets occur sometimes to the root ends on the side toward which the tooth is being hammered.

Such a maladjustment of the tooth surfaces to the mandibular movements has been named traumatic occlusion, and the injury caused by it, occlusal trauma. It may come, of course, from developmental malocclusion, but this is not the chief cause. When the teeth erupt irregularly, they are subjected to strong lateral stresses and usually develop strong bony processes for support so that there is good resistance. Frequently, dentures of considerable maladjustment of this type will go to later life with little if any symptoms of occlusal trauma. The chief cause of traumatic occlusion is a progressive maladjustment due to excessive wear or, more important still, the shifting that occurs after extractions combined with faulty bone metabolism.

Statistics by Brekhus show that, in women, 47 per cent of the lower first molars on one side or both sides are lost by the age of 20, and 75 per cent by the age of 40. The figures are a little less for men. Most of these lost teeth are not replaced at once by bridgework. With few exceptions, the loss of the lower first molar, if unreplaced, leads to shifting and tipping of the teeth, which will finally affect every tooth on that side of the mouth. Loss of other teeth when unreplaced, or the presence of cavities that destroy the contact supports, may have a similar effect, although usually it is not so severe. Restorations made without regard to the mandibular movements may cause, and usually do cause, occlusal trauma and eventual loss of the supporting teeth. Rapid shifting and weak resistance to stress is undoubtedly greatly increased by the defects in metabolism which frequently occur because of the faulty diet and conditions of modern living.

Impaired nutrition of the periodontal tissue cells may occur in several ways. A sluggish or deficient blood supply is one. In many persons, periodontal structures are thin and frail and teeth irregular and crowded, little, if any, space being left between for supporting tissue. Such thin, frail and compressed tissue with a minimum of blood flowing through it naturally has not the resistance of that which is well developed. Nonocclusion or a lack of masticatory function leads to a sluggish blood supply. The periodontal tissues of unused teeth frequently become so degenerated that they cannot be placed again in function, soreness or rapid loosening following any effort in this direction. The gingiva is a tissue fitted to stand mechanical abuse. A

natural, coarse diet gives abundant massage to this tissue. The modern diet of soft pasty food gives none of it. Sluggishness of the blood supply from this lack of function is an important reason for the low resistance of this tissue to bacterial invasion and mechanical irritation.

General systemic factors may also cause lowered resistance and vitality in the periodontal tissues. The cells of the tissues about the teeth are bathed and nourished in the same fluid that bathes and nourishes all the other cells of the body. A lack of necessary nutrient elements or the presence of toxic agents injures them as it does all others. Frequently, the effect of such systemic faults is noticed first on the periodontal tissues because of their being on the verge of breaking down from local causes such as bacterial accumulations or traumatic injury. Thus, it is a common complaint to hear that a patient's teeth get sore during every cold, or the teeth loosen or tighten as the patient feels ill or well.

It is possible by feeding diets defective in certain respects to produce periodontoclasia in animals that are ordinarily immune. Lack of calcium in the diet, combined with a lack of any one of two or three of the vitamins, has been made to cause it in rats and monkeys. Dogs usually get it when fed the diet of most American families. There is every reason to think that periodontoclasia is frequently due in large measure to dietetic errors because of which certain food elements necessary to normal cell metabolism are not present in sufficient amounts. A peculiar form of gingivitis usually associated with pregnancy is thought to be due primarily to the increased demands for certain food elements which are insufficient in the diet at that time. Constipation, which is likewise usually an effect of dietetic faults, is a common concomitant of periodontoclasia. Probably both are due to much the same errors.

Toxic products in the blood stream are particularly damaging to the gingival and periodontal cells. Almost any severe or chronic illness is accompanied by gingivitis, if not periodontoclasia. The coated tongue and teeth and fetid breath of fever are indications of the increased bacterial growth in the mouth at that time. Nephritis and diabetes are particularly injurious to the gingivoperiodontal tissues and, if these conditions are not corrected systemically, the local treatment in the mouth may be of very little effect. Any chronic illness, such as tuberculosis, syphilis or cancer, or even overwork, lack of sleep or worry, will undermine the vitality of the cells about the teeth sufficiently to add greatly to the difficulty of restoring them to health.

There is nothing mystic in the treatment of periodontoclasia. It is simply a matter of discovering the causes of irritation and lowered vitality about the affected teeth, eliminating these causes and stimulating the circulation to the point of healing. No magic drug or form of radiant energy or set of instruments or special technic has so far been devised which, by itself, will do these three things.

Frequently, if not usually, more than one of the causative factors, namely bacterial invasion, chronic mechanical injury and lowered cell vitality, are operating at the same time, and the relief of one of the factors alone may be sufficient to turn the scale in favor of healing. It is for this reason that favorable results can be truthfully reported from several widely differing types of treatment, each of which has influence on some one of the causative factors. Thus, exclusive

attention to root surface treatment alone in the early days cured many cases. In many practices, exclusive attention given to diet reform or adequate home care technic or relief of mechanical irritation may show favorable responses in large numbers of the cases treated. Such one-sided treatment will leave many cases unchanged and cannot be so certain in any case as a comprehensive treatment that takes all factors into account.

The treatment for relief of bacterial accumulations consists locally in the scaling and smoothing of the root and crown surfaces of the teeth, followed by home care which will keep them clean. The root surface scaling consists principally in the removal of subgingival or serumal calculus, but should also involve a curettement of the cementum in order to leave it as smooth as possible. This is a matter which, to do thoroughly and rapidly, requires much practice, skill and a nice discrimination, for the root surfaces beneath the gingiva are out of sight and require, for their efficient handling, the development of a tactile sense more acute than almost anything else in dentistry or medicine. Many structures must be known and recognized by touch, such as serumal calculus, whether rough or smooth, cementum, unfinished and finished, dentin where the cementum is cut through, the springy attachment of the gingiva to the tooth, and rough enamel margins, besides the irregular forms of the roots themselves in their normal and abnormal shapes.

All of these structures convey their peculiar sensations through the sharp cutting or exploring instrument to the hand and brain of the operator, where they must be analyzed and distinguished. So difficult is this that, although the idea is simple, comparatively few dentists ever get very proficient at it. The deeper the pockets, the more difficult the technic. It is fortunate that the vast majority of affected teeth that are not too far advanced in disease to be saved have comparatively shallow pockets which are easily reached and in which fairly efficient apoxesis or root surface technic can be carried out by the dentist in general practice.

The technic depends on the use of sharp curetting instruments so shaped that they can be made to reach easily and work efficiently to the nethermost depths of the pockets. For this purpose, several types of instruments have been devised, such as hoe scalers, curet scalers, periplanes of Towner and prophylactic files. In the hands of an experienced periodontist, any of these types can be made to do the work. Efficient apoxesis lies much more in the operator than in the instrument or set of instruments. On the whole, the tendency of the last ten years is to decrease the number of scalers to comparatively few, say from ten to twenty. More elaborate sets increase the difficulty by complication more than they decrease it by more accurate adaptation of instrument to tooth surface.

The technic consists in detecting the scales of calculus and unpolished areas of root surface and dislodging the calculus and gently shaving the root surface to a point of polish. Properly planed cementum feels like polished ivory to the sharp explorer or scaler. Calculus, even if smooth, feels like stone to the sharp scaler or explorer. All the unattached root surface must be gone over until it is finished. No more than the least amount of shaving necessary to accomplish this should be done as it is very easy to cut through the cementum into the dentin beneath. The cementum in the gingival third of the root is as thin as a fine hair. If it is cut through, the

porous granular layer of Tomes is exposed; and thus a surface is left which feels woody to the explorer or scaler and cannot be rendered smooth, is always sensitive to the patient and is irritating to the soft tissue lying against it.

Root surface technic should be accomplished with the least amount of injury possible to the soft tissues. Profuse temporary hemorrhage is often unavoidable on entering beneath a highly engorged congested gingiva. There is probably no harm in letting this blood escape. But there should be the minimum of trauma from apoxesis for other reasons: Laceration of the gingiva by tearing, scratching or stretching increases greatly the pain of the operation both during the time and for forty-eight hours afterwards. It may also lead to more recession than is necessary. The line of attachment at the base of the gingival crevice is extremely sensitive when it is inflamed. Very great unnecessary pain and discomfort may be caused by punching instruments down into it farther or more often than is necessary to determine its location. The periodontal tissues in periodontoclasia are highly infected, that is, deeply penetrated and filled with bacteria. Manipulation of such tissue necessarily forces large numbers of bacteria out into the blood stream. The effect of this is frequently a reaction, with rise of temperature, rheumatic pains and other symptoms a few hours after operating. This reaction may be very dangerous in a patient with rheumatic fever or valvular heart disease. In such patients, but little operating should be done at each sitting, with four or five day intervals between sittings. In any event, the smallest amount of laceration and injury possible should be done consistent with accurate root surface technic.

Many operators attempt to treat all the teeth a little at each sitting. The bulk of superficial deposits are removed the first time, and at each sitting thereafter uncompleted pockets are entered farther and farther, until no symptom of an open pocket remains. The difficulty with this method lies in the tendency of the gingiva to tighten about the neck of the tooth as the superficial deposits are removed, leaving the untreated pockets beneath, which it is difficult later on to discover or enter.

The other method consists in treating only as many teeth at each time as can be completed at that sitting, as far as the sense of touch can determine this point. Usually, from two to eight teeth an hour can be treated by an experienced operator, this depending on the difficulty encountered. After all the teeth have been completed in this way, a careful check has to be made to determine that pockets have actually closed and that no symptoms of subgingival deposits or roughness remain; for no operator is 100 per cent perfect in this work through sense of touch alone.

The so-called surgical methods of treating periodontoclasia either of the resection type or the flap operation type are not generally approved as routine procedure by periodontists. Health of the gingiva is acquired very rapidly by these methods, but it is obtained at the cost of unnecessary loss of tissue, leaving the root surfaces much more exposed than is necessary. A number of objectionable features accompany the exposure of such root surfaces.

Perhaps even more important than the accurate root surface technic is the follow-up care by the patient. It is in failing to train patients to do their part that many excellent operators fail to achieve lasting results in periodontia. Two ob-

jects are to be accomplished by the home care of the teeth: (1) accurate cleansing of the tooth surfaces and (2) massage of the gingiva. For these purposes, the interdental method of tooth brushing as modified by Charters seems to fill the requirements better than any others. Space and time forbid going into the detailed specification of the ideal toothbrush or the method of using it, or the use of dental floss when indicated. The Charters technic is well known and has been fully described many times in the literature. Suffice it to say that the teeth stay clean only a few hours after treatment without regular efficient follow-up care by the patient. The massage given by the toothbrush properly used must be depended on to reestablish a normal circulation that brings healing and restoration to the congested, infected tissue. Successful results in periodontia depend more on enthusiastic and efficient cooperation by the patient than on any other single factor.

The treatment of mechanical injury to the periodontal tissues is frequently a very difficult matter. It is frequently impossible to treat loosened, shifted, leaning teeth in such a way as to relieve excessive stress imparted to them by the mandibular movements. Grinding is often a necessary temporary expedient, but it is usually not enough to restore a mechanical adjustment. Teeth are designed to receive stress in the direction of their long axis. If markedly tipped from this position, they must be braced to withstand the lateral stress. As the alveolar process recedes, the mechanical disadvantage of a lateral stress becomes more marked. If it is impossible to relieve the lateral stresses in the teeth already loosened, the condition of such teeth is hopeless and they should be extracted.

Teeth with periodontoclasia are being extracted more now than formerly as the limitations of treatment are coming to be recognized. The experienced periodontist may, with some hope of success, treat teeth with pockets near the apices or those badly loosened by occlusal trauma, but the general practitioner would do well not to attempt it. It is far better to remove the isolated, tipped and loosened teeth and those with hopelessly deep pockets even if it means total extraction and full dentures than to wage a losing fight with hopelessly diseased teeth, increasingly large partial dentures and the systemic ill-health that comes from periodontal infection and disease.

Having determined on the teeth which can be saved, the mouth should be built up to approximate as nearly as possible ideal mechanical relations. This involves a knowledge of occlusion and restorative procedures which cannot be discussed within the limits of this paper. In most cases of traumatic occlusion, the bite is closed, and this condition cannot be corrected by grinding alone. Where grinding is indicated, it should be done in such a way as not to disocclude the tooth. When carbon paper is used, the point of occlusal contact is usually ground away. The disoccluded tooth promptly extrudes to meet its antagonist and, in a few days, the traumatic occlusion becomes as bad as before. Grinding should cut away the interfering surfaces in lateral movements while maintaining the points of occlusal contact in centric occlusion. Much judgment, knowledge and experience are necessary to determine which of the antagonizing surfaces to grind and how to build up to get occlusal relations which will be comfortable and will maintain the teeth in health.

Raising the resistance and vitality of the periodontal tissue cells frequently

involves the cooperation of the physician. The dentist should know systemic hygiene and should study his cases to see where lapses are interfering with his results. The detailed prescription of a diet for a patient who is obviously suffering from dietetic error had perhaps better be placed in the hands of the physician. General advice as to the hygiene of food, habits, activity, sleep, work and recreation should be given with references to books for the patient's own reading. Many patients have individual idiosyncrasies needing special treatment which the dentist is unprepared to discover or treat. Dietetic advice by the dentist in some of these cases may do more harm than good. Cordial cooperation between physician and dentist best meets the needs of the patient.

There is no one universal panacea for periodontoclasia. Successful treatment depends on a discovery of the causes and their elimination, together with a restoration of tissue and organ function. Drugs and elaborate apparatus have little place in rational therapy. The essentials are knowledge of the causes, skill in instrumentation, enthusiasm in getting patients trained and cooperation in eliminating systemic defects. The treatment is definite, and when it is undertaken with understanding, the results are as certain as those from any therapy in modern medicine.

POSTOPERATIVE CARE IN THE SURGICAL TREATMENT OF PYORRHEA*

By A. W. WARD, D.D.S., San Francisco, Calif.

HERETOFORE, we have understood pyorrhea surgery to mean surgery of the cementum; that is, scraping of diseased roots. There are so many men now eradicating pyorrhea that, when I speak of pyorrhea surgery, I shall be understood to mean removal of all diseased tissues about the affected teeth.

All of the soft tissues involved in pyorrhea pockets in cases of long standing are permeated with bacteria. The peridental membrane in the pocket area is also permeated in the denuded bone as well. It is through the thorough removal of all infected tissue about pyorrheic teeth that pyorrhea can be considered as eradicated.

Several years ago, discussing the focal infection problem, Dr. Mayo said that the next step must come from the dentists. I believe pyorrhea eradication is the step which Dr. Mayo meant, although he did not know it at the time. But now that surgical eradication is practiced in the dental department of the Mayo Clinic, Dr. Mayo no doubt has seen so many wonderful systemic benefits following the eradication of pus pockets about teeth that he knows dentistry has made good.

*Read before the Section on Orthodontia and Periodontia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 21, 1928.

In order that you may better understand my postoperative procedures, I shall briefly state when I consider the operation necessary: (1) whenever roentgenograms show breaking down of the alveolar crust; (2) when soft tissues are chronically hypertrophic; (3) when teeth have not erupted to their full length and there is a considerable unattached soft tissue; (4) after the acute stage of Vincent's infection, if any pockets exist.

The diagnosis having been arrived at by means of (1) complete roentgenograms; (2) a study of teeth in occlusion and the various excursions of the mandible; (3) a comparison of the length of the tooth roots with the remaining alveolar support, and (4) vitality tests (no pulpless teeth to be retained). If operation is decided on, the following procedures are concluded: preoperative Wassermann test; blood count (differential); test for clotting time, and urinalysis.

If a general anesthetic is to be administered, a heart and lung test is made by a physician. It is best at all times to work with patient's physician. I find medical practitioners anxious to cooperate. If operation is to be done with a local anesthetic and the patient is nervous or apprehensive, from one-sixth to one-fourth grain of pantopon is administered from twenty minutes to one-half hour before procain injection is begun. Food should not be partaken of previous to administration of gas or any other general anesthetic, but is advisable before a local anesthetic. If procain is the anesthetic, a 2 per cent solution to which has been added from 3 to 6 drops of epinephrin to the ounce of solution should be used.

The patient is covered with a large sterile sheet. In all my cases, I employ a surgical table, but in the dental office the chair may be used if all levers are covered with sterile towels or cloths. (I have recently designed a large sheet which goes over the patient's head, covering all parts of the body, also the chair.) Gloves are worn by the operator, and sterile gauze packings and sponges are placed on the instrument table with the instruments. The instrument table is placed back of the patient. The patient's hair is covered with a sterile towel, and the face is washed with 70 per cent alcohol and the entire mouth, except the lips, is painted with mercurochrome, 4 per cent. Block anes-

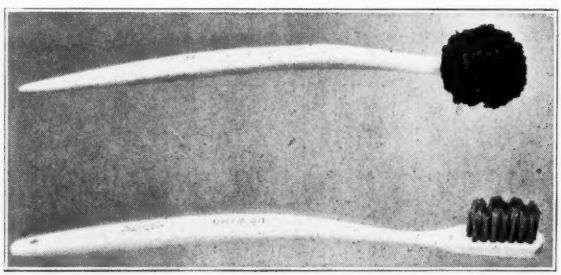

Fig. 1.—Rubber massage brush and hard bristle brush advocated for use by patients as described in the text.

thesia is used on the mandible and infiltration for the maxilla. I inject the upper gums first, but do not begin operation until I have injected the lower.

Operation is begun at the median line all soft tissue in the approximal space being removed, and the approximal alveolus being freshened at the same time with approximal curet No. 1. The same procedure is carried out as far posteriorly as is possible with a straight curet, and the same procedure is used with push and pull curets No. 2, 3, 4 and 5, until all approximal spaces are thoroughly curetted. Care must be exercised not to roughen the cementum, but all thickened peridental membrane must be removed with other soft tissue. The curets are reversed to remove calculus.

There are now a series of cuts through the soft issue in the approximal spaces extending to the full depth of the alveolar area of destruction, leaving gum flaps labially and lingually. These are removed with instruments Nos. 6, 7 and 10. For the anterior labial area, a small portion of alveolus is chipped away with instruments No. 6 or 7 to insure removal of carious bone. Also the cementum is freshened and calculus removed on the labial surface with the same instruments at this time. Instruments 6 and 7 are used as far posteriorly as the No. 1 curet was used. Then, because of the interference by the corners of the mouth, Nos. 8 and 9 are used to remove buccal gum tissue. The alveolar borders are freshened with bone hoes Nos. 11 and 12. The lingual gum tissues are removed

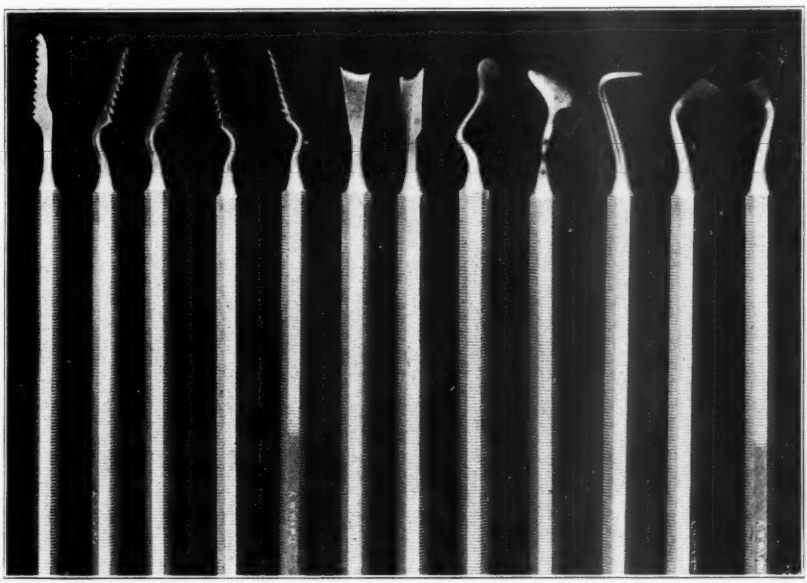

Fig. 2.—Complete set of instruments used in surgical eradication of pyorrhea as described in the text.

with knives Nos. 8 and 9, and the alveolus freshened with bone hoes as on the buccal surface of molars and bicuspids. No. 10 is used to remove lingual gum tissues of the six anterior teeth, and the bone is freshened with same instrument.

I have described the operation for the maxilla. The same procedure is used for the mandible. The same instruments are used in identical location as in operating on the maxilla.

As a rule, the entire mouth is operated on at one sitting, but men who are beginning the work cannot hope to accomplish so much at first.

As regards the postoperative procedure following surgical eradication of pyorrhea pockets, the first step is the packing of the wounds, which is done with a surgical cement, "wondrpak" mixed thick and forced through the approximal spaces in such a manner as to lock it in place. Sufficient surplus is packed through to cover the adjacent lingual surfaces of teeth and gums, and this acts as the lock. All approximal spaces are filled and all borders operated on are covered.

This packing is designed to remain in place over the operative areas for ten days or more, not less; the reason being that, by that time, the primary clot under the packing is organized and there is sufficient fibrous tissue to protect the alveolus and prevent pain.

The packing has a number of results: First, it acts as a splint if the teeth are very loose and more or less immobilizes them until they can support themselves. It is also a soft tissue splint. In all surgery, the hope of the surgeon is to immobilize injured parts. In a broken bone or an incision, the better the parts are apposed or immobilized, the better the surgical result. It is just as important to immobilize the soft issue adjacent to a wound in the mouth as elsewhere in the body. To form an idea of what immobilization of tissue means, consider how annoying such a little thing as a hang-nail may be. If it is pasted down with collodion, it immediately becomes

Fig. 3.—Progressive steps in the surgical eradication of pyorrhea alveolaris as originated and advocated by the author.

better; if it is cut off, it does not hurt at all. The same thing applies, as I said before, in the immobilization of gum tissues. The packing accomplishes immobilization of the teeth, an immobilization of soft tissues. It also desensitizes the roots; it allows the patient to eat immediately as the excursion of food over the wound would otherwise be painful, and it cements the infection out. The packing hardens in about ten minutes.

The patient is kept in the office for a little while to see that there is no further bleeding. He is then instructed to take a small dose of mild mercurous chlorid (calomel), usually 3 grains in 1 grain doses, in combination with 5 grains of sodium bicarbonate to each grain; that is, 15 grains of sodium bicarbonate to 3 grains of calomel, to be followed in the morning by magnesium sulphate (Epsom salts). Afterwards, the patient is instructed, when there is no further danger of salivation, to take copious quantities of orange juice or other citrus fruit juice. He is encouraged and told that he can eat many things, such as custards, hamburger steak, fish, cheese, bread, all kinds of milk drinks, eggs and other soft foods. If we do not tell our patients these things, they sometimes do not eat enough. There is usually no pain; very little, if any, rise in temperature, and rarely any reaction. Compare this to the scaling method, when, if too many teeth are scaled at one time, it is not an uncommon thing to have a reaction.

The day following, the patient returns at the hour specified and we merely examine the packing and paint around the edges with mercurochrome 4 per cent or a mixture of camphor and phenol. This is not necessarily an important thing, because the packing takes care of the danger of infection; but it gives the patient confidence and it makes him feel that we are taking the best of care of him.

After the second day's visit, we see the patient in three days and again three days later. On the tenth day, the packing is removed. This is best accomplished with a hook instrument, in the line of the incision, and pulling toward you, breaking off the labial portion of the pack, and leaving the approximal and lingual in one piece which is readily pushed away. It probably seems rudimentary to describe how the packing is to be taken off, but some men have difficulty with it, and therefore I have explained my method.

The packing being removed, the patient is instructed in the proper method of brushing, and this is without a doubt a task "for all that a man has of fortitude and delicacy." It is sufficiently difficult to teach some patients to brush at any time, but when we have performed a gingiva-alveolus débridement —which I think is the word that should be used—our task is greatly increased. I have tried to instruct patients to brush the teeth immediately with a hard brush, but have met with great opposition; so I have devised a brush which is made of rubber. Being circular, it adapts itself perfectly to the teeth and soft tissues. It is so soft that the patient will use it immediately, which you must insist on. The difficulty in this work is not in getting a good surgical result, but in teaching the patient to harden the new tissues. The patient, in four or five days, by the use of the soft rubber brush, will have his soft tissues condensed. Usually at the end of ten days or two weeks, we can start him on a regulation

brush. The bristles of this brush should be very hard and so set that they will fit over the labial and lingual surfaces and into the approximal. It is the approximal gum that is most difficult to reach in brushing, and that is therefore most often neglected. The handle of the brush should be so shaped that the ends of the bristles are in a straight line with the handle. The sense of touch is only transmitted in a straight line.

It is best to extract teeth in which the alveolus has been lost in the bifurcation. Sometimes, there exists a deep pocket on one surface of a tooth, and on the teeth adjacent, the bone is very good; in other words, a lineal alveolar destruction which the eradication or the removal of the soft tissue in the curettage of the alveolus will not necessarily eradicate. Almost immediately, the gum fills in, and, in a very short time, it appears as if it had never been operated on. Consequently, the only way to eliminate the pocket is to take a little of the alveolar process off adjacent to the area of lineal destruction. After this, we must pack for a long time.

At subsequent sittings, the occlusion is harmonized. There is a certain school of periodontia that believes almost wholly in the cure of pyorrhea by the grinding or the balancing of occlusion. That is, to my mind, a fallacy. Following my method of eradication, many times it is not necessary to touch a tooth in the mouth with a stone. I do not wish to minimize the importance of balancing or harmonizing the occlusion. If there are overhanging cusps that limit the excursion of the mandible, correction must be made. But it is a fallacy to think that, when the peridental membranes are swollen and engorged and are pushing the teeth out of their sockets, the removal of some tooth surface will cause the teeth to settle down again in the socket. Nothing will cause the teeth to return to their normal position except the surgical removal of the infected tissue around the teeth and the carious alveolus.

MEANS OF INCREASING EFFICIENCY AND DECREASING TRAUMA IN FULL DENTURE SERVICE*

By A. Y. RUSSELL, D.D.S., Baltimore, Md.

IT is not my purpose to add to the already voluminous amount of material on the theory of prosthesis, but rather to describe briefly the practical application of means of increasing efficiency and decreasing trauma in full denture service.

It is of more than passing interest to note that teeth are lost mainly from two causes: dental caries and pyorrhea; of the underlying causes of which we have little or no knowledge. When teeth are lost, it becomes necessary to supply artificial substitutes.

An agreement has been reached by those who have taken time to investigate that mandibular movements are habitual and individual, and dentures constructed

*Read before the Section on Full Denture Prosthesis at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 22, 1928.

by methods using the average mandibular movements are not acceptable.

Many methods and mechanical contrivances have been introduced to aid in the reproduction of the individuality of the movements of the mandible. Failure of these methods is not always caused by

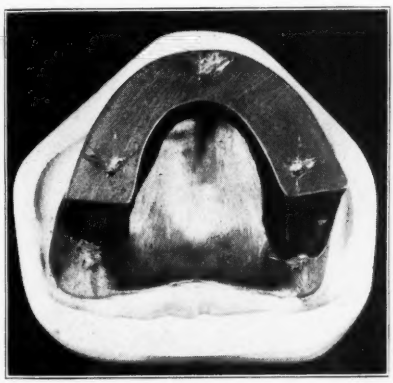

Fig. 1.—Metallic bite plane.

Fig. 2.—Cutting bar carrying round burs.

the machine or so-called articulator, but is more often due to inaccuracies in the method of securing registrations.

Much emphasis has been placed on various phases such as impression taking, articulation and arrangement of the teeth. It is my conviction that most satisfactory results can be obtained by establishing the maxillomandibular relation, by recording the individual habitual mandibular movements, by obtaining close adaptation, by giving attention to dietary habits and exercise and by the modification of tooth forms.

ESTABLISHING THE MAXILLO-MANDIBULAR RELATION

The necessity for the establishment of the maxillomandibular relation has long been apparent to observing students in the construction of dentures. But means and methods of procedure to accomplish this result have been inadequate. Now, this relation, for practical purposes, may be established within certain limits by the use of a metallic, dynamic bite originated by Dr. Highkin, of Balti-

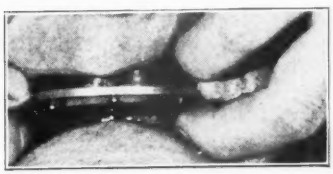

Fig. 3.—Cutting bar in the mouth ready for mastication.

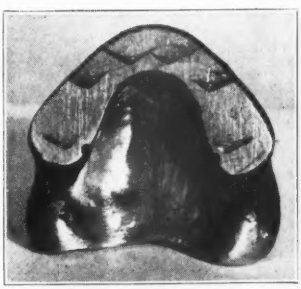

Fig. 4.—Cast showing that the anterior portion of the cutting bar worked faster than the posterior.

more. The metal plane is placed on a substantial maxillary bite-plate as shown in Figure 1. A cutting bar carrying No. 5 round burs, as shown in Figure 2, is placed on the mandibular bite-plate. The patient is now instructed to begin the operation of mastication (Fig. 3). After a very short time, it may be observed that the anterior portion of this

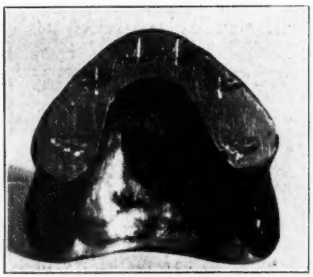

Fig. 5.—Cast showing that the posterior portion of the cutting bar worked faster than the anterior.

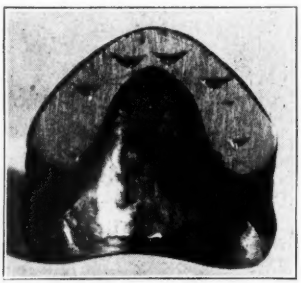

Fig. 6.—Grooves or paths properly cut by habitual mandibular excursion.

cutting bar is working faster than the posterior (Fig. 4). This indicates that the maxillomandibular relation is too close. If the posterior is working faster than the anterior, the relation is too wide (Fig. 5). This relation may be increased or decreased nearly to the extreme without materially affecting the efficiency. The space between the extremes allows a sufficient distance for change in esthetics. The greater danger lies in allowing the maxillomandibular relation to be too close.

RECORDING HABITUAL MANDIBULAR MOVEMENTS

The maxillomandibular relation having been properly established, the patient is now allowed to continue the act of mastication until grooves or paths are formed in the maxillary metal plate (Fig. 6), and the habitual mandibular excursion is comfortably established, thereby producing a metallic dynamic

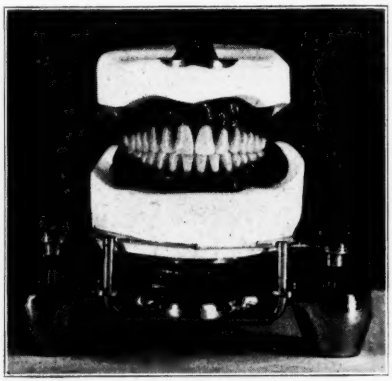

Fig. 7.—Case set in centric occlusion (anterior view).

Fig. 8.—Portion of edentulous mandible with insufficient calcium.

bite. The grooves thus formed represent the length, width and depth of the excursion of the mandible as controlled by the muscles of mastication when in action.

The metallic dynamic bite is now transferred to the machine or so-called articulator, so constructed as to utilize the grooves or paths to reproduce the habitual mandibular movements of the case.

Fig. 9.—Case shown in Figure 8, five weeks later.

Fig. 10.—Teeth showing excess deposition of calcium.

The artificial substitutes are now arranged in proper relation to the ridge, to harmonize with the movements produced by the machine while following the paths made by the patient during individual habitual masticatory action. Thus, balanced occlusion is obtained in each case in harmony with the individual's mandibular movements (Fig. 7).

Registrations of checkbites to be used with adjustable articulators have been obtained with the least possible pressure. They do not compensate for masticatory action or tissue resiliency.

"If the masticatory surfaces are ground to suit the geometric condition of the case, it may still be necessary to compensate for yielding of the tissue under chewing force. A scientific technic for the compensation of tissue resiliency

Fig. 11.—Case shown in Figure 10, six weeks later. The improvement is the result of change of diet.

Fig. 12.—Teeth showing excess deposition of calcium.

may offer a legitimate field for the checkbite or a record obtained under biting force."[1] By using the metallic registration or dynamic bite produced under individual normal mastication action, we have compensated in a great measure for the geometric conditions and the tissue resiliency of the case.

1. Sears, V. H.: Balanced Occlusion, J. A. D. A., 12:1448 (Dec.) 1925.

The area to be covered by the denture base is rather definite.[2] Any attempt to cover more or less will increase trauma and likewise decrease efficiency. The overextended denture base will, at first, show great stability; but, in a short time, will become loose, owing to muscular pressure brought to bear dur-

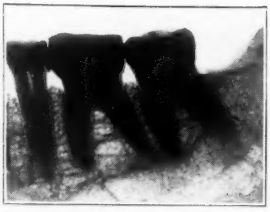

Fig. 13.—Case shown in Figure 12, six months later, with no change in diet, but sufficient exercise to eliminate excesses.

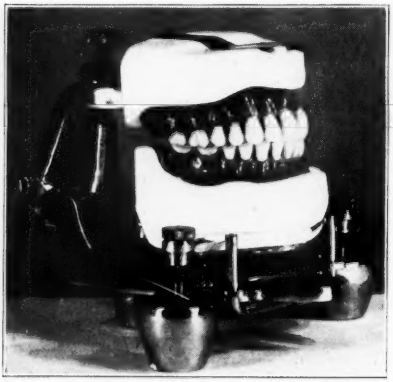

Fig. 14.—Centric occlusion (lateral view).

ing the acts of mastication and deglutition. Bases not extended to cover prescribed areas will show a lack of stability, trauma resulting thereby. The areas to be covered by the denture base should be in close areal contact except over the hard spots in the vault, which may be properly relieved.

2. Paterson, A. H.: Dent. Cosmos, 62:978 (Aug.) 1920.

DIET AND EXERCISE

Recommending diet and exercise is well within the field of the prosthodontist, provided he has taken the time and pains to inform himself as to the requirements of each case.

The majority of denture-wearing patients are past the developmental age, foods for development no longer being necessary. Only proper foods in suffi-

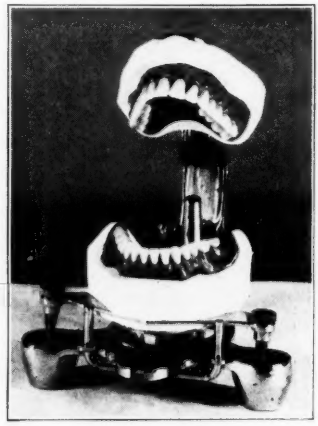

Fig. 15. — Open case showing channel posterior teeth set on new model Highkin articular.

cient quantities to maintain health are needed.

Complete roentgen-ray examination should be made, and the bone condition noted; then dietary changes may be intelligently made to suit the case. Figure 8 shows a portion of edentulous mandible with insufficient calcium. Figure 9 shows the same case five weeks later, after a change of dietary habits. Figure 10 shows excess deposition of calcium; Figure 11, the same case six weeks later,

after a change of diet. Figure 12 shows excess deposition of calcium; Figure 13, the same case six months later with no change in diet but sufficient exercise to eliminate the excess. This indicates that diet should be prescribed to suit the individual's exercise, or that exercise should be planned to suit the diet given.

MODIFICATION OF TOOTH FORMS

Most present-day tooth forms are carved after the plan of Nature's best forms. However, during mastication with the natural teeth, each tooth has its individual built-up resistance and limited amount of movement. But, since prosthetic substitutes are supplied with no such resistance and movement, they should be constructed from carvings; not after the plan of nature, but after the best mechanical arrangement suitable to the artificial situation created by the loss of the natural teeth.

Tooth forms, to produce efficient mastication with the least possible trauma, must necessarily be carved to accommodate the three typical goemetric classifications given by Dr. Highkin: angular, lateral, and anteroposterior; with marked reduction in occluding areas.

The carvings by Victor H. Sears (channel posterior teeth) come nearer to meeting the foregoing requirements than any I have been able to obtain on the open market. (Figs. 14-15.)

CONCLUSIONS

1. The jaws have a vertical relation in centric occlusion in harmony with the contraction of the muscles of mastication.

2. Balanced occlusion of the teeth can be obtained with or without proper jaw relation.

3. Adaptation distributes the forces over stress-bearing areas.

4. Proper diet and exercise help to retain stress-bearing areas and increase resistance.

5. Tooth forms conforming to the typical geometric mandibular movements with marked reduction in occluding areas increase efficiency and decrease trauma.

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DISCUSSION

Ralph L. Christy, Denver, Colo.: Trauma in artificial dentures is as serious, if not more so, than in natural dentures. One of the main causes for trauma in artificial dentures is that the central occlusion of the teeth is not in harmony with the centric relation of the mandible to the maxilla. If I understand Dr. Russell correctly, he gets the centric relation under pressure, and when it is taken under pressure, it is liable to throw the central occlusion out of harmony with the centric relation. I contend that the centric relation should be taken without pressure, taking into consideration the resiliency of the tissue under the denture bases. The same holds true with the protrusive and lateral checkbites. Also, it is necessary to have a relaxed patient in all steps of denture construction, especially in recording jaw relations. Regarding the area covered by the denture base, there should be a definite pressure on the stress-bearing area of at least 20 pounds, during mastication and without pressure on the nonstress-bearing areas. I agree with Dr. Russell regarding diet and exercise, and feel that if we instruct the patients in these, there will not be the absorption that there would be otherwise. As to the selection of tooth forms, too much attention has been paid by the prosthodontist in the selection of anterior teeth and not enough to posterior. Ewell Neil has given one of the greatest aids to the dental profession in the technic of the lower impression, together with the selection of the posterior teeth for a given case. That is, to measure the distance from the distal edge of the cuspid to the anterior edge of the postdam, draw a line perpendicular on the cast at the center of this area, the mesial buccal cusp of the first molar

should be over this line. If we do not have this space filled with teeth, we have a shunting of our upper denture anteriorly. I have never used the channel posterior teeth, but I do add a bicuspid and sometimes a molar to fill this area from the cuspid back to the anterior border of the postdam, in order not to use teeth too large buccolingually. Dr. Cummer says that the stress-bearing area should be at least two and a half times greater than the occlusal area of the posterior teeth. When the stress-bearing area is small on the lower, I level the lingual cusp, thus reducing the occlusal area. It is my opinion that one of the best ways to eliminate trauma is by making arbitrary checkbites on the instrument in centric relation, and carrying this to the patient's mouth, letting them tell us by the tactile sense of the cusps of the teeth whether all the cusps come into this bite at once without pressure. The patient can tell us this, but it could not be seen by us. We can see whether there is a shunting of the bases. The same holds true with the making of an arbitrary postrusive bite to see if the condyle indications are correct. The check should be made at the time of trying in and before milling, and should be made in wax of uniform thickness and consistency. I thoroughly agree in the use of the teeth with small occluding areas, and will give the channel teeth a trial. Let me say again, the greatest reason for trauma is that the occlusion is not in harmony with the centric relation, and this can be corrected by arbitrary checkbites and the tactile sense of the cusps of the teeth. Dr. Russell's paper is on one of the most important phases of denture construction. I would like to have discussed that most important subject, decreasing trauma and increasing efficiency, at further length in relation to the different steps of denture construction, but it seems to me that the main object of this paper is to interest the dental profession in the use of channel teeth.

George H. Henderson, Chicago, Ill.: One of the troubles brought out by Dr. Russell is the difference in the pressure on the soft tissues of the mouth in the taking of the impression and the bite. Impression and bite taking, as well as the trying-in if it is used to correct the bite, should all be conducted under the same pressure. If there is a difference in the thickness of these soft tissues, and a certain pressure is put on the impression, and a greater or less pressure is put on the bite, the case will not be mounted in the same relative position on the articulator that it would have been held in the mouth. I have had forty-five sets of teeth made for my upper jaw, and if one-half of the men in this room were forced to wear artificial dentures, there would soon be such a decided improvement in our dentures that our patients would appreciate the difference. I have had dentures ground in on an articulator, and when the incisal guidance pin was changed, the dentures did not fit or occlude as they did before. Therefore, one essential is to keep the incisal guidance pin, exactly where it was placed when the case was mounted, when setting up or grinding in teeth.

Dr. Russell (closing): Dr. Christy criticizes the method of obtaining centric relation and favors nonpressure methods. My contention is that, during mastication, there is individual pressure and direction of mandibular movements, so why not record all of these individualities while obtaining centric relation? He stated further, "The object of this paper seems to be to interest the dental profession in the use of channel teeth." I tried to evade this problem as much as possible. In recommending the modification of tooth forms, no mention was made that forms would not be further modified; I stated that channel posterior teeth come nearer meeting the foregoing requirements than any I have been able to obtain on the open market. Dr. Stansbery questions the grinding process because of the possibility of the denture base skidding. If the maxillomandibular relation is correctly established, skidding is reduced to minimum. When the patient begins to grind, there is necessarily some lateral pressure, but you may remember that I said, "Allow the patient to continue mastication until the mandibular movements are comfortably established." As soon as there is resistance, there will be cutting, and when there is cutting, resistance will be eliminated. When the grooves are ground in to where the patient can comfortably establish the mandibular movements, this, in my opinion, is the most comfortable relation for dentures. Dr. Stansbery answered his question by describing how U. S. soldiers have their shoes fitted to working conditions under pressure. We are by this method

obtaining the metallic dynamic bite under normal pressure of the individual's mastication action. As to the point brought out by Dr. Henderson relative to changing the guidance pin and in grinding the teeth in finished dentures when the case did not fit as well as before, I refer to the last sentence of the paragraph "Establishing the maxillomandibular relation: The greater danger lies in allowing the maxillomandibular relation to be too close." This answers Dr. Henderson's question. Since the guidance pin was lowered, the maxillomandibular relation was too close.

DO ALL CYSTS IN THE JAWS ORIGINATE FROM THE DENTAL SYSTEM? (WITH A REPORT OF TWO NON-DENTAL CYSTS LINED WITH CILIATED COLUMNAR EPITHELIUM)*

By THEODOR BLUM, D.D.S., M.D., F.A.C.D., F.A.C.S., New York City

IT is remarkable that in spite of their frequency, so little is known of cysts of the jaws, particularly as to their origin. Clinically, they are, as a rule, quite apparent, and readily diagnosed and even treated, if all the means at our disposal are employed to arrive at the proper diagnosis. It may seem superfluous to mention at this time the importance, not of the ordinary roentgen-ray examination in difficult cases, but of the more detailed and special technic. The latter is necessarily indicated in that type of cyst which develops very singularly from the buccal roots of those maxillary teeth which have more than one root, but even from the apices of single rooted teeth if they are very close to the buccal or labial periosteum and only a very thin plate of bone or no bone at all has to be perforated by the pathologic process to permit the formation of the granuloma, and, if containing epithelial cells, later on the cyst proper, in the soft tissues covering the buccal or labial side of this bone. In these cases, a shadow of the cyst can be shown only on a film placed between the mandibular and maxillary teeth with the rays parallel to the long axis of the teeth in the involved region. (Fig. 1.)

Fig. 1.—Shadow of cyst shown on film placed between mandibular and maxillary teeth with rays parallel to the long axis of the teeth in the involved region.

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 22, 1928.

To be in a position to discuss later on the question raised in the title of this paper, one must refresh one's memory with the three different types of cysts which are found as a rule in the mandible and maxilla, namely, the radicular cyst (Figs. 2-3), which takes its origin from a diseased tooth root, the follicular cyst (Fig. 4), which develops around the crown portion of a malposed tooth, and the multilocular cyst (Figs. 5-6), of which little is known except that, for certain reasons mentioned below, it is somewhat on the borderline between a benign and a malignant tumor.

To emphasize the value of the latest and best theory of the origin and development of radicular cysts, a paragraph from a previous discussion[1] will be cited here:

> The important monograph of Erich Becker[2] must be mentioned to clear up most of the points on the origin of radicular cysts described by Dr. Aison. Becker maintains that the immediate cause of radicular cyst formation is hemorrhage into the pericemental membrane brought about by bacterial, traumatic or chemical action. The *sine qua non* for the formation of a radicular cyst is a devitalized pulp and the presence of epithelial rests (Malassez) in the pericemental membrane. Not every granuloma contains these rests and, therefore, not every granu-

Fig. 2.—Radicular cyst originating from first maxillary molar, developing in the maxillary sinus. The outline is almost circular.

1. Blum, Theodor: Disc. of Aison, E. L.: Dental Cysts and Their Surgical Treatment, J.A.D.A., 15:1437 (Aug.) 1928.
2. Becker, Erich: Radicular Cysts, No. 2, Meusser Collection, 1920.

loma changes into a cyst. A radicular cyst can develop without a granuloma from the pericemental membrane provided the membrane contains epithelial rests. The blood accumulated in the pericemental membrane at the point of the hemorrhage coagulates, and if the coagulum surrounds the blood serum instead of the opposite (this whole process is analogous to cyst formations in the brain, bone and other parts of the body), the serum is not absorbed by the surrounding tissues, but it forms the nucleus of the cyst fluid, which is increased through the products of degeneration of the connective tissue and blood vessels enclosed in and strangulated by the proliferating cells. The epithelial rests of Malassez are remainders of Hertwig's sheath and, therefore, are postembryonic cells. The radicular cyst developing from them is benign, while the multilocular cyst develops from the

Fig. 3.—Radicular cyst.

anlage, which is made up of embryonic cells and is, therefore, on the borderline toward malignancy.[3]

Under ordinary circumstances, one would think a differential diagnosis rather superfluous when dealing with cysts. Past experiences have led me to believe that attention to differential diagnosis will, in a number of cases, obviate embarrassing errors. Even a normal anatomic structure such as a large incisive foramen has been mistaken for a cyst (Figs. 7-9) or for an area of absorption in the apical region of a central incisor. (Fig. 10.)

Osteitis fibrosa (cystica) (Figs. 11-13) and certain giant cell tumors (Fig. 14) appear on the roentgenogram as very similar to multilocular cysts and could easily be taken for such a cyst, unless one is experienced not only in the actual clinical examination, but also in the reading of roentgenograms. Even the endothelioma (Fig. 15) which occasionally develops in the region of the posterior portion of the hard palate gives one, on the roentgenogram, an impression of cyst formation.

While all the above mentioned conditions are fairly benign, a malignant tumor resembling epidermoid carcinoma was in one instance diagnosed roentgenographically as a cyst by a general roentgenologist, until a careful study of the roentgenogram, as well as the clinical examination, proved it to be a tumor, which, only after operation, was finally diagnosed as epidermoid carcinoma (Fig. 16.)

Fig. 4.—Follicular cyst caused by supernumerary tooth.

The case which prompted me to write this paper is reported herewith:

CASE 1.—*History.*—B. R., a man, aged 28, who came in for the first time, May 8, 1928, complained chiefly of a discharge of fluid

3. Kruse: Development of Cystic Tumors of the Lower Jaw, Virchow's Arch., Vol. 124.

from an opening in the roof of the mouth in the region of the incisive foramen.

His present illness dated from about two years previously when he had first noticed a swelling in this region accompanied by discharge and slight soreness. After a few days, the condition subsided, but it had recurred at frequent intervals until about a year previously, when the swelling became slightly larger. He visited a dentist who took a roentgenogram and advised the removal of the two maxillary central incisors and curettage of a cyst. The patient refused treatment, and the swelling subsided until about six months previously, and again subsided without treatment, but left a fistulous opening until the present time.

The past medical history revealed that the patient had been very athletic and had sustained injuries to the face and nose at different times. About two and one-half years previously, the patient fractured the nasal bones and sustained severe injuries of the neighboring structures during a plunge while swimming.

Examination.—Clinical examination revealed a marked gingivitis with some soft and hard deposits and bleeding spots, especially in the lower anterior teeth. On the palatal side just posterior to the four anterior teeth, the tissues were slightly more prominent; and just posterior to the incisive papilla, there was a very small fistulous opening discharging on pressure a drop of thick greenish yellow pus. To the pulp test, all the remaining upper teeth proved normal. Roentgen-ray examination (Fig. 17) revealed a shadow approximately 1.5 cm. in length and 0.75 cm. in width in the region between the two central incisors, the larger part of which was on the right side. The peridental lamella around these anterior teeth seemed continuous; in other words, normal.

Fig. 5.—Multilocular cyst.

In presenting this patient, I stated that, because of the vitality of the pulps of all maxillary teeth, we probably were dealing with a cyst developing from the dental system; namely, a dental follicle without calcification, the histologic examination of which would probably reveal the presence of one or all types of cells which form the different elements making up a tooth. Following is a descrip-

tion of the operation which was performed:

Operation.—A left infraorbital injection and circumscribed palatal infiltration anesthesia were given. The gingival pyramids between the upper teeth from the first bicuspid on the left to the second bicuspid on the right, inclusive, were cut, and then the free gingiva separated from its pericemental attachment all along the palatal side of the aforementioned teeth. The muco-periosteal flap so outlined was elevated, and the incisive vessel and nerves cut. When the flap was retracted, one could see, in the region of the incisive foremen, a large opening in the palatal plate along the median line, approximately 1.75 cm. in diameter. As it appeared that the cyst itself was of a larger diameter than the opening, the bony covering on the periphery of the cyst was chiseled away, at which time greenish yellow thick pus exuded from the cyst. The edges of the bone which were removed were found to be very hard and the border of it round, not as it is found in cysts in which the buccal plate of bone has been absorbed and the edge of the bone is thin and sharp. The whole cyst was then peeled out *en masse,* and a fairly smooth bony cavity came into view, the anterior surface of which ran down the incisive structures; all débris was removed and the flap replaced, and, after application of argyrol, held in position with plain gauze placed over the whole wound (Fig. 18).

Histologic Examination.—The tissue removed was sent to a medical laboratory with instructions for serial sectioning. After examination of sections at certain intervals, the pathologist came to the conclusion that he was dealing with an embryonal tumor of the adamantinoma type. While this diagnosis would have confirmed my preoperative impression, I felt that a further study of the specimen should be made by a dental pathologist. Lester R. Cahn completed the study, reaching the conclusion that the columnar epthelial cells found were ciliated. He felt

Fig. 6.—Multilocular cyst.

Fig. 7.—Incisive foramen sometimes mistaken for a cyst.

Fig. 8.—Incisive foramen.

Fig. 9.—Incisive foramen.

(after carefully studying the history of the case) that we were dealing with a cyst developing from the nasal epithelium which was probably misplaced into the region where it was found, at the time of the accident in which severe injury to the nose occurred two and one-half years previously. (Fig. 19.)

Dr. Cahn consented to discuss Case 1, and to report another case (hereafter referred to as Case 2) from his own practice:

A histologic examination of the tissues reveals a fibrous zone and an epithelial one. The latter is of most interest. Two types of epithelium are to be seen, namely, a stratified squamous type characteristic of oral

Fig. 10.—Incisive foramen in apical region of central incisor resembling area of absorption.

epithelium and a ciliated one peculiar to the respiratory tract.

From a history of the case, we find that the cyst was situated palatally to the anterior teeth and not associated with them. There is a history of trauma.

The origin of this cyst is difficult to imagine. A group of nasal epithelial cells might have been detached by the trauma, and stimulated into cyst formation. After the formation of the fistulous opening in the region of the incisive papilla, oral epithelium must have proliferated into the cyst cavity, the larger part of which was lined with ciliated columnar epithelium.

Following is the report of a case (below referred to as Case 2) of a cyst of the jaw not associated with a tooth.

CASE 2.—*History.*—Miss B. F., aged 40, for some time had had a small bleblike elevation between and below the cervical margins of the lower right cuspid and bicuspid teeth, on the buccal gum. The patient was told to watch it, and if it increased in size or became painful, was to report.

About three months later, the patient returned, saying that she believed that the lesion was getting larger and that it was beginning to give discomfort.

Examination.—It was noted that the little growth had increased to almost twice its former size. It was now about one-quarter inch in diameter, and looked very much like a "water-blister." It was bluish grey.

Operation.—Under local infiltration anesthesia, a mucoperiosteal flap was raised. The outer alveolar plate was gone and a membrane was adherent to the flap. This membrane lined a tunnel-like excavation between the bicuspid and cuspid and extended back to the lingual plate, which was intact. The lateral boundaries of this tunnel did not involve the roots of the bordering teeth. It looked as though a membranous tube had been implanted between these teeth. The membrane was easily peeled out and dissected from the flap. Clinically, the condition was a cyst, the peculiar shape of which was due to its anatomic situation.

Histologic Examination.—Paraffin sections were made of the membrane and stained with hematoxylin and eosin. The tissue, which was very thin, was composed of a scanty fibrous outer layer and an inner epithelial one. The epithelial cells were of the squamous variety and were closely packed together. The outer zone was composed of adult fibrous tissues and evidenced little inflammatory reaction. The tissue was that of a cyst membrane but was growing under considerable compression. (Fig. 20.)

In the case just described, a cyst not associated with a tooth was growing in the jaw. Its membrane was histologically similar to those found in the usual types, and I believe had exactly the same origin. A group of epithelial cells, probably from the remnant of the enamel organ of some tooth, remained or found their way into the alveolar bone. There,

owing to some irritation, they formed a cyst. What the irritation in this case was it is very difficult to say. Bacteria or their toxins do not seem to play a part, and the irritant was probably mechanical. It might have been due to the too vigorous use of the toothbrush.

This theory of epithelial cell rests as the forerunner of jaw cysts has its analogy in the embryonal rest theory of Cohnheim as to the cause of neoplasms.

Fig. 11.—Osteitis fibrosa (cystica).

CASE 3.[4]—*History.*—S. M., a woman, aged 32, came in Nov. 3, 1927, complaining of swelling of the face next to the left nostril. There was slight pain on pressure. The patient also suffered from headaches and earaches. About six months previously, she had had a cavity in the upper left central incisor filled. The next day, the face became swollen and painful in this region. The dentist opened the tooth and drained the pus through the canal. The roentgen rays revealed a pulpless tooth adjoining, which the dentist removed as being the cause of the pus formation. For two weeks, the patient had the dressings changed in the socket of the left maxillary lateral incisor at forty-eight hour intervals. Thereafter, the socket was allowed to close. Headache and earache appeared at about the time of the swelling; drainage of the pus in the arc of the left maxillary central and lateral incisors relieved the pain somewhat. Two months before, the patient had called the physician's attention to a slight swelling inside the left nostril. He aspirated it through the nose and obtained several cubic centimeters of greenish yellow fluid. The next day, the face became swollen as at the time when the dentist had worked on the central

4. Reported previously in Blum, Theodor: Clinical Oral Surgery (Part Two), Internat. J. Orthodontia, 14:795 (Sept.) 1928.

incisor. Pain was also present. The dentist drained additional pus through the canal of the central incisor. Several days later, the patient went to another dentist, who extracted this tooth. Pus was drained through the socket for six weeks, additional pus being obtained each day. The headaches failed to improve, and the patient lost 15 pounds during this time. She then consulted a rhinologist, who referred her to me.

Examination.—There was swelling on the left side of the nose involving the left nasal chamber and the nasolabial fold and part of the adjoining cheek. The skin and subcutaneous tissues were movable over a swelling which fluctuated on palpation. The left

Fig. 12.—Osteitis fibrosa (cystica).

Fig. 13.—Osteitis fibrosa (cystica).

maxillary central and lateral incisors had been lost and there was a piece of gauze in the socket of the central incisor. The fold in the region of the central and lateral incisors and cuspid was partly obliterated by this swelling, which fluctuated intraorally. It was impossible to establish communication between the socket and the area in question. Roentgenograms of the parts failed to disclose any pathologic process of the bone in the affected area (Figs. 21-22).

Operation.—Under local infiltration and infraorbital conduction anesthesia, a semilunar incision was made on the labial side extending from the median line to the apical region of the left maxillary cuspid. The mucoperiosteal flap was then dissected away from the sac which appeared about a 1 cm. above the ridge and which had very slightly absorbed the outer plate of bone adjoining the nasal chamber. The sac was then dissected from the scar and granulation tissues adjoining it and in this procedure the lateral nasal mucous membrane was penetrated. The nasal chamber was closed off by a plastic flap from within the wound. The incision was then closed and sutured.

Fig. 14.—Giant-cell tumor.

Fig. 15.—Endothelioma.

Pathologic Report (Frederick E. Sondern).—Macroscopic examination: The specimen consisted of an irregularly shaped piece of tissue measuring 1.3 cm. in length. The tissues appeared to be cystic and the wall was composed of firm white tissue.

Microscopic examination: Sections showed a cyst wall composed of fibrous connective tissue and lined with a columnar epithelium, which in several places formed a double layer. (Fig. 23.) Toward one end of the structure, the lining was composed of ciliated epithelium. (Fig. 24.) Just beneath the lining, there was considerable round cell and an occasional polymorphonuclear cell infiltration. There is no histologic evidence of malignancy.

Diagnosis: Inflammatory cyst was diagnosed.

After-Treatment.—Two days later, the piece of iodoform gauze inserted into the left nostril at the time of the operation was removed. There was a slight swelling of the face in the surrounding area. Five days after the operation, the four sutures used in closing the flap were removed. The plastic closure of the lateral wall of the left nasal chamber had been done with catgut, so this was left undisturbed. Argyrol, 25 per cent, was applied to the parts at regular intervals, and five weeks after operation, the patient was discharged.

This radicular cyst formed on the labial side in the region of the central and lateral incisors. Apparently, both teeth were involved although we can assume from the usual position of the apex of the lateral incisor that the cyst in question originated from the central incisor. There was a very shallow indentation of the labial plate which one would ordinarily ignore and consider normal. In spite of the fact that the cyst was entirely in the soft tissues and that during the time of the operation no connection with the dental system could be found, the history of the case suggests a radicular

Fig. 16.—Epidermoid carcinoma.

cyst and the microscopic findings show an epithelial lining characteristic of it. The ciliated epithelium described in the same specimen was part of the mucous surface of the nose and was removed at the same time.

In Case 3, I believed that I had found an interesting case with which to stress the importance of differential diagnosis, namely, between Case 1, in which the cyst was lined with ciliated columnar epithelium, and Case 3, in which apparently only the nasal part of the specimen was so covered. When reading Dr. Sondern's report again and carefully, and after examining the slide with Dr. Cahn, I realized that the entire cyst cavity was covered with columnar epithelium (not found in dental cysts) which, in one part, was ciliated. Therefore, the previous diagnosis of radicular cyst originating from the left maxillary central incisor was wrong. We are dealing with a cyst related to the nasal mucous membrane. The loss of ciliae over the greater part of the cyst lining can be easily explained by the acute and subacute inflammations which repeatedly attacked the cyst.

The difference between Cases 1 and 3 lies in the fact that the former developed in the bone, while the latter probably did so in the soft tissues covering the bone, causing only a slight but noticeable loss of osseous tissue.

I am of the firm belief that, as a rule, all cysts in the jaws originate from the dental system. Even if a full complement of vital teeth is present, there is still a possibility of the development of a cyst from epithelial (squamous) rests or supernumerary tooth follicles in the jaw bone. The cyst in Case 1 was caused by the displacement of nasal epithelium into the maxilla through trauma. What forces caused the formation of the one in Case 3 in the soft tissues, it is difficult to explain. All these cases emphasize the importance of the microscopic examination of all tissues removed from the oral cavity. Oral pathology is only in its infancy. Many clinical tumors are found, under the microscope, to be only chronic inflammation. Are there transitional stages to actual tumors? What is the relation between osteitis fibrosa, osteitis fibrosa cystica, giant cell tumor and sarcoma? Every practitioner cannot also specialize in oral pathology, macroscopic and microscopic, but we all can, for the benefit of humanity, support the real student who studies this subject. Our hope does not rest with the general pathologists. Readers of their chapters on

Fig. 17.—Roentgenogram from Case 1.

Fig. 18.—Roentgenogram from Case 1.

oral pathology will be convinced of this.

101 East Seventy-Ninth Street.

DISCUSSION

Harry Bear, Richmond, Va.: Dr. Blum's classification of cysts and the theory of their origin leave little room for debate. He stresses, and rightly so, the necessity for a careful clinical study and also a proper roentgen-ray interpretation. The clinical findings should be supported, as he suggests, by a careful history of the case, for this is too often minimized. A proper roentgen-ray interpretation can be made only after one is satisfied that an adequate roentgen-ray examination has been done. It is needless to repeat here the errors of roentgen-ray interpretation so frequently made in this field, owing to a lack of understanding of the parts involved and incomplete roentgen-ray examinations. Differential diagnosis, a major consideration, should always be borne in mind here as in the general field of medicine. Dr. Blum has called to our attention the value and the necessity of a microscopic examination of oral tissues, not so much for what it furnishes in confirming the diagnosis of the

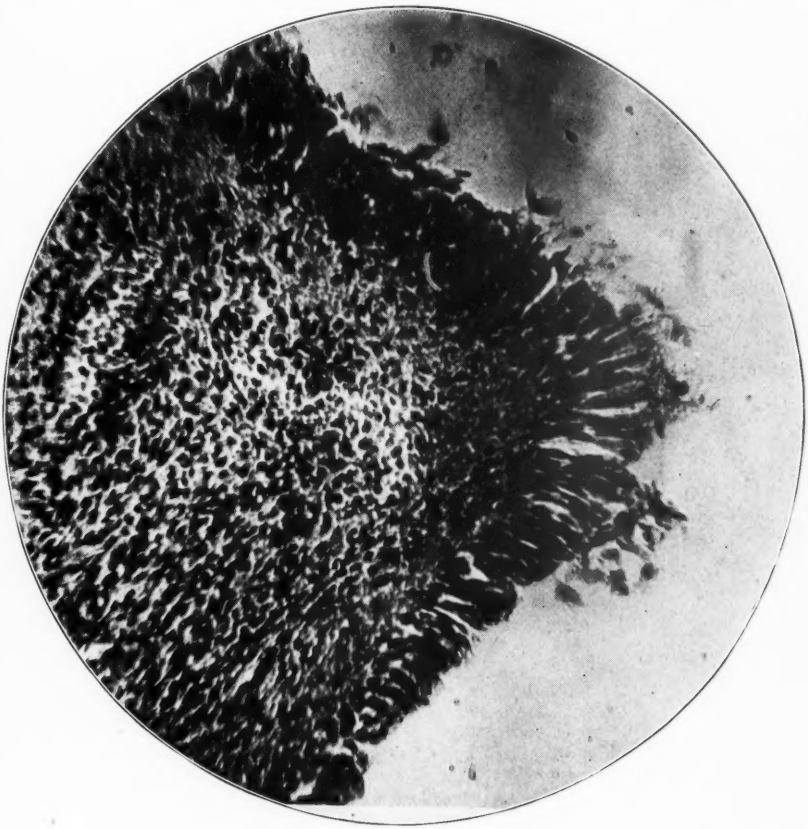

Fig. 19.—Cross-section of cyst in Case 1.

particular case at hand, but as a means of furthering a more complete and intelligent understanding of this subject.

Frank B. Hower, Louisville, Ky.: The report of the three cases emphasizes the necessity and value of study of cysts. Most of us are given to haste in their treatment. By this, I mean that we are concerned with the successful accomplishment of the task before us. Valuable data, a natural accompaniment to all operations, are often passed by, and perhaps much has been lost in determination of the etiology of cysts because of this widespread neglect of the biologic and pathologic data present. It is the duty of every diagnostician to take into consideration the probable etiology of all cysts which come to his attention. The three cases presented should stand as examples for all those interested in this work. I should like to emphasize just one or two points in connection with these cases: First, there is the difficulty of diagnosis of cysts in the multirooted teeth of the maxilla. This is made especially difficult because of the close proximity of the maxillary sinus. Even with roentgenograms made from many angles, it is quite frequently necessary to obtain all the clinical data possible to obtain the correct diagnosis. The roentgen-

Fig. 20.—Cross-section of cyst from Case 2.

ray technic which Dr. Blum describes for this type of case should prove of great assistance. The operator is justified in turning back a mucoperiosteal flap when he anticipates conditions of this character. Good judgment should always be exercised before any surgical step is taken even for diagnostic purposes. Case 1, which involved nasal epithelium, is of great interest because of the frequency of cases of traumatic origin involving the nasal tissue as well as dental structures that come to men in our line of endeavor. Carl Waldron, of Minneapolis, in his paper before the American Society of Oral Surgeons and Exodontists, brought out a point that should not be overlooked; that is, that we should keep as a part of our records a specimen of tissue in all cases that may be looked on with suspicion. This should apply in cases of cystic conditions even though they are believed to be of the simple type. Microscopic examination is most certainly justified in all of these cases. Even if the operator does not wish to make an examination, he should at least preserve a specimen of the tissue.

Fig. 21.—Affected area in Case 3.

Fig. 22.—Affected area in Case 3.

Carl D. Lucas, Los Angeles, Calif.: Dr. Blum has accomplished as much in the study and the determination of the etiology of cysts as any man in our group. There is one condition which could not be called a cyst but should be considered in our discussion of cysts which Dr. Blum did not emphasize. In the case that I have in mind, the roentgenograms disclosed that practically the entire cancellous structure of the body of the mandible from the lower cuspid tooth on the left, back to and including the unerupted third molar, in the mouth of a girl, aged 12, had been dissolved by the action of the enzymes in the serum which had been liberated beneath the periosteum, owing to trauma. In this case, each tooth in the patient's mouth was proved to be vital by the Faradic test. In determining the etiology of the condition, we found ourselves in difficulty because of the fact that there was no limiting membrane surrounding the region which had been dissolved from the body of the bone. In discussing the case with men who are familiar with surgical lesions, we determined that the dissolution of bone was caused through traumatic injury, rupture of capillaries within the inner portion of the periosteum, liberating serum underneath the periosteum which caused enzymolysis of the cancellous tissues of the body of the mandible, a condition simulating osteomalacia. We were very careful at operation to be conservative in the matter of retaining all of the vital teeth which were involved in the area. Each one of the teeth, being vital, was retained; the operation was performed intra-orally, and the sanguinoserous contents of the cavity were aspirated. Animals were inoculated to determine whether there might be any evidence obtained through animal inoculation which would differentiate the destructive process as either sarcomatous or a tuberculous degeneration. Guinea-pigs were inoculated and cultures were made from the area and found to be absolutely sterile. The animals were not made ill by the injections, and the culture medium, which was also inoculated, remained sterile for sixty hours' incubation. That is one type of osseus destruction which Dr. Blum did not mention in his paper, therefore I present it for your consideration under the subject

of differential diagnosis of intraosseous areas of rarefaction.

Dr. Blum: I am very much interested in Dr. Lucas' case of so-called bone cysts. We are all in the habit of using wrong terms. I am not referring to Dr. Lucas but to myself and to all the pathologists who speak of cysts, especially of the long bones, when the growth is not lined with some sort of membrane. Dr. Lucas is very fortunate, indeed, to have come across such a case in the jaw or in the mandible in his particular case. I have never seen one, and I have never read a report on one. I believe that he ought to report this case so that it can be referred to. I wish again to emphasize that these conditions are due to trauma in most instances, and to note that, in these cases, hemorrhage occurs in the bone; and that if in these cases the serum of the coagulum which naturally forms is inside the coagulum, a cavity will form in the bone which we all speak of as bone cysts. But they are not true bone cysts. This same theory of hemorrhage being the cause of the formation of these cavities in the bone was applied to cyst formations in the jaw in the theory which Erich Becker has advanced. He believes, as I have said in my paper, that hemorrhage

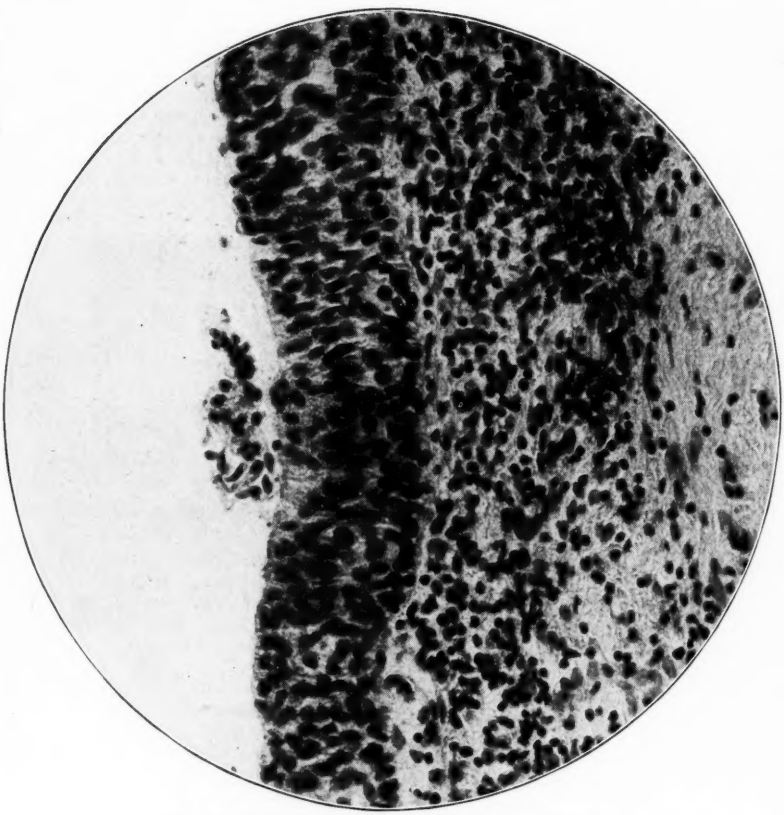

Fig. 23.—Cross-section of cystic tissue from Case 3.

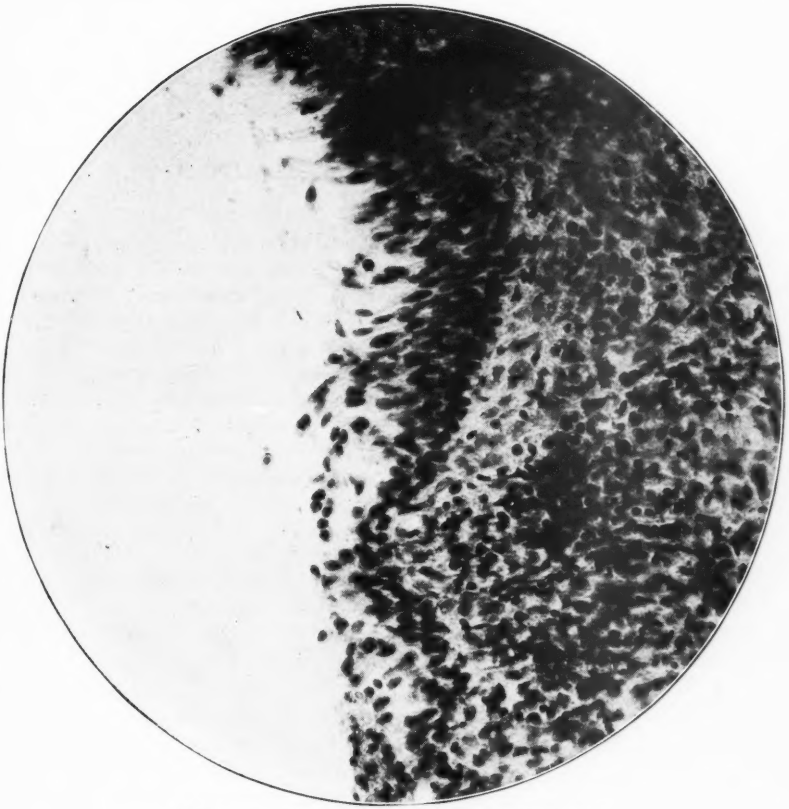

Fig. 24.—Cross-section of cystic tissue from Case 3.

occurs in the peridental membrane, the blood coagulates, and if the serum is surrounded by the coagulum instead of the opposite, a cyst will form, if epithelial rests are present in the peridental membrane.

A HISTORICAL SKETCH OF THE AMERICAN SOCIETY OF ORAL SURGEONS AND EXODONTISTS (1918-1928)*

By HARRY BEAR, D. D. S., Richmond, Va.

AUG. 7, 1918, there assembled at the Congress Hotel in Chicago a number of exodontists and oral surgeons from cities throughout the United States. This assemblage was in response to an invitation sent out by M. R. Howard of Denver, Colo. It must not be forgotten that this gathering was held during a period of turmoil and unrest. The United States was at war and the dental profession was busy mobilizing its strength in order to contribute its quota of service men. It was in such an atmosphere and at such a time that the efforts of a number of exodontists were pooled and the first steps taken to perfect an organization.

At this meeting, temporary officers were elected and various committees appointed. On the following day, after the formalities were disposed of, the American Society of Exodontists was launched as a permanent organization. Twenty-eight members were elected, this number constituting the charter list. Fifteen states were represented on the roster.

The first annual meeting, which was held in New Orleans, La., was taken up with further plans for perfecting and strengthening the organization. For the past ten years, the Society has held its annual meetings in the city where the annual session of the American Dental Association has convened. The high standard and excellence of the programs and clinics have been maintained with each successive meeting. In 1921 and again in 1923, the society held joint sessions with the National Society of Denture Prosthetists as a part of their general program. These meetings were of decided advantage to members of both organizations in developing a better understanding of the common problems concerning the two specialties and as an aid to their solution. In 1921, the society held an invitation meeting at The Mayo Clinic, Rochester, Minn., prior to its regular meeting in Milwaukee, Wis.

The society changed its name in 1921 to the American Society of Oral Surgeons and Exodontists. The entrance requirements have always been of high standard, while the acme of professional ethics is one of the tenets to which the membership vigorously adheres. The society has steadily grown in numbers, and our members come from all parts of the United States, thirty-four states and the District of Columbia being now represented. We have at the present time, 130 active members and one honorary member. We mourn the loss of our other honorary member, C. Edmund Kells, of New Orleans, La., who passed away during the past year.

During the past ten years, many problems of considerable interest have arisen,

*Read before the American Society of Oral Surgeons and Exodontists, Minneapolis, Minn., Aug. 17, 1928.

as would naturally be expected in the early years of any organization. Much discussion has centered about the advisability of admitting as members dentists from outside the United States. The society has taken the same stand here as that taken by the American Dental Association, i. e., only residents of the United States are eligible for membership. The question as to whether meetings should be limited to our membership or be open to the profession at large has also been presented for debate. There have been advocates on each side, and without doubt there are many virtues to commend either stand. It is the present attitude of the society that our purposes are best served by restricting attendance to our membership and to guests who are sponsored by our members.

The matter of the publication of papers has also given the society much concern. Many plans were submitted and various offers tendered, but the society is on record as advocating that the JOURNAL OF THE AMERICAN DENTAL ASSOCIATION continue as the medium for publication of our scientific papers.

The society has indeed passed its formative stage and is now upon an assured foundation. Its aims and purposes have always been high and, as one of the great cosmic health agencies, it has dedicated its services to the common good of humanity. In reaching this, our tenth, anniversary, we are stepping out, as it were, from infancy into a healthy growing childhood. Were I to essay the rôle of a prophet, I should venture the prediction that this society will continue to grow in service and usefulness and become eventually an authoritative body affecting the specialties in which we are engaged.

As you know, tin is the symbol of a tenth anniversary. As it is with the pure metal, so it has been with this society: we have gone through a process of refining and now exemplify the metal in its pure form. This metallurgical element has a fitting and peculiar significance for the dental profession; it is a constituent of many important alloys. And so is this society an important unit among the many organizations of the dental profession, exerting its efforts for the good of every member, individually and collectively, for the profession at large, and for the welfare of the public as a whole. It is with justifiable pride that we must uphold its traditions and ideals, both by precept and example. The achievements of the past decade set a goal for future accomplishments.

410 Professional Building.

PARTIAL GOLD SADDLE CASES AND CLASP ATTACHMENTS*

By EDWARD T. TINKER, D. D. S., Minneapolis, Minn.

IN my discussion of partial gold saddle cases and clasp attachments, I realize that I shall meet a wide divergence of opinion on several points connected with the construction of these cases.

I have, in the past few years, formed some very decided ideas, and in applying them, have attained the desired result, in a measure, in a large percentage of cases.

Briefly, the essential features are as follows:

1. *Mouth Preparation.*—A thorough roentgenographic examination must be made. From this examination, we proceed to clear up the pathologic conditions, should any be disclosed. If surgery is necessary, the operation should be performed in such a way as to lead to as symmetrical healing as possible.

In preparing a case, extraction is not always confined to infected teeth. It is fully as important that teeth so badly malposed from their normal position that they cannot be brought into normal function by crowns, or, in some cases, orthodontia, should be removed.

A temporary plate should now be inserted and worn for a period of from at least six to eight months before final construction of the case, this being a part of the case that should never be hurried. In many of these cases, extensive operative work is required on the teeth remaining in the mouth to insure a comfortable occlusion. I will not go farther into this phase, except to mention its imperativeness.

2. *Diagnosis.* — Good study models should be taken of many cases and mounted on a proper instrument. In the less intricate ones, working models are sufficient.

Figure 1 illustrates one of the most common conditions met with in either the upper or the lower jaw. The bicuspids are clasped. If the case is an upper, indirect retention is attained by the two flanges extending lingually and anteriorly to a point in the region of the lateral incisor. In a lower, the connecting bar, placed as it is, acts in the same way.

Figure 2 illustrates an upper case in which all the teeth are lost between the cuspid and the second molar on one side, and posteriorly to the bicuspid on the opposite side.

It is my opinion that two clasps are all that is required in the majority of cases, and, when it is at all possible, they should be placed where they will exert the most stabilizing influence; in this type, the bicuspid on the one side and the molar on the opposite.

In addition to the two flanges illustrated and described in Figure 1, a third one is carried around the lingual aspect

*Read before the Section on Partial Denture Prosthesis at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 22, 1928.

to the distal aspect of the molar, where it has a firm seat on the tissue, acting as a means of indirect retention in conjunction with the direct clasp retention on the bicuspid on the opposite side, holding the case in its position from the molar to the bicuspid. In the cuspid, we plan an inlay in which a socket is cut that will accommodate a strong rest lug, extending from the mesial aspect of the first supplied bicuspid, and serving to prevent the case from exerting pressure on the mucosa at this point, under the force of mastication.

Figure 3 illustrates an upper case in which the cuspids, bicuspids and one

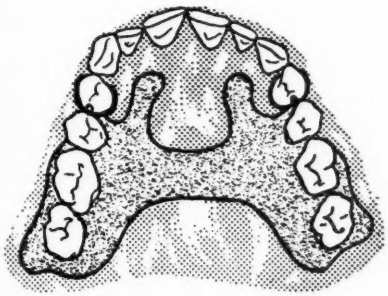

Fig. 1.—Clasps attached to bicuspids; a condition commonly met.

or more molars are missing.

Some form of an inlay is made on the distal aspect of the two lateral incisors with a socket placed to receive a rest lug extending from supplied cuspids on either side. One molar on either side is clasped, and indirect retention extended posteriorly as illustrated. As long as the clasps are in their respective positions, the case cannot drop from the region of the cuspids.

The palatal bar, in this instance, is placed farther forward than in the previous illustrations, and, in some cases, an additional strengthening bar is added between the two indirect retainers at the posterior border.

Figure 4 illustrates a lower case with all teeth removed posteriorly to the first bicuspid, excepting, possibly, one or both second or third molars on either side.

The outstanding difference in the handling of these cases with similar

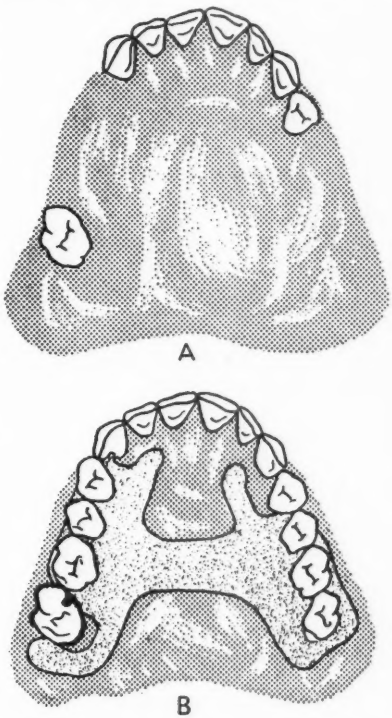

Fig. 2.—*A:* Upper case in which all the teeth are lost between the cuspid and the second molar on one side and posteriorly to the bicuspid on the opposite side. *B:* Restoration of case shown in *A*.

cases in the upper jaw lies in the fact that we do not have the dropping of the case with which to contend. Consequently, we always use the anterior

abutments for the clasps, and place rest lugs in the marginal ridges of the molars, which gives us as many points of suspension as possible.

In the study of the cases already outlined, we have dealt with that type having no teeth missing anteriorly to the anterior abutments. Figure 5 illustrates an upper case in which we have missing a lateral incisor on one side and a first bicuspid on the opposite side, the second bicuspid being in place. In this type of restoration, I prefer to supply the missing two teeth with fixed bridgework; first, because the second bicuspid is stabilized very materially as an abutment to carry a removable denture posterior to it, and, secondly, because I do not believe it good practice to carry a single tooth on a projecting arm anteriorly from a saddle which has for its abutment tooth a bicuspid. There is always too much movement to such a tooth, and they fail to function as they should. The saddles supporting them are too small to give proper foundation for their support, and the fulcrum is placed in the wrong position.

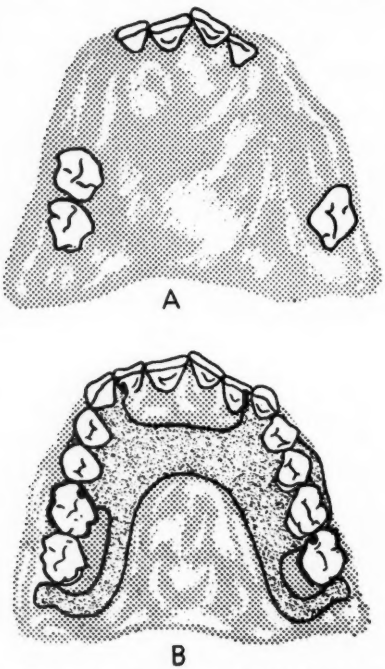

Fig. 3.—*A:* Upper case in which the cuspids, bicuspids and several molars are missing. *B:* Restoration of case shown in *A*.

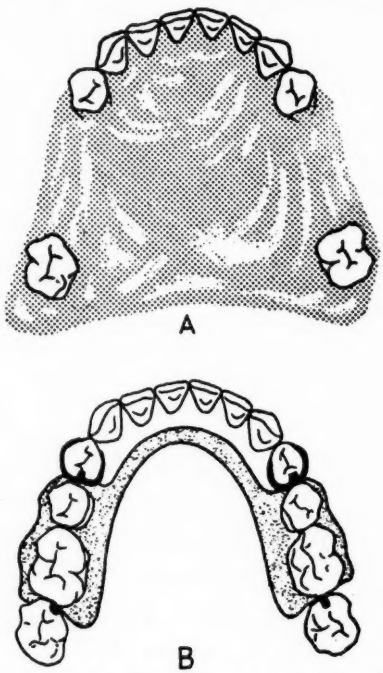

Fig. 4.—*A:* Lower case with all teeth removed posteriorly to the first bicuspid except the third molars. *B:* Restoration of case shown in *A*.

Figure 6 illustrates a lower case in which we have remaining a cuspid and a bicuspid on one side, and a cuspid and possibly a second or third molar on the opposite side.

In this type of case, I invariably place a fixed type of structure supplying the anterior teeth, building the lone cuspid to somewhat resemble a bicuspid, in order that it may retain a clasp. On the opposite side, I, as a rule, make a double abutment by joining the cuspid and bicuspid. If there is a molar remaining, I place a strong supporting rest lug in its marginal ridge.

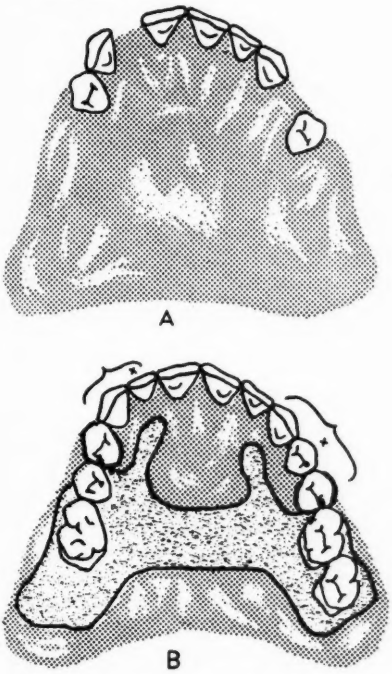

Fig. 5.—*A:* Upper case in which there is a lateral incisor missing on one side and a first bicuspid on the opposite side, the second bicuspid being in place. *B:* Restoration of case shown in *A*.

By replacing the anterior teeth with a fixed structure, we not only insure a much better appearance, but also our abutments are not subjected to torsion as with four anterior teeth carried from an extension saddle, since the ridge supporting the anterior teeth does not have the stress-bearing resistance sustained by the broader ridges in the posterior areas. Consequently, teeth supplied in these anterior regions on saddles do not keep their position up to the plane of occlusion.

In the several cases discussed, I have dealt with types met with in various practices. Frequently, cases present themselves which require a great deal of individuality in technic, and we must vary our methods to meet the demands.

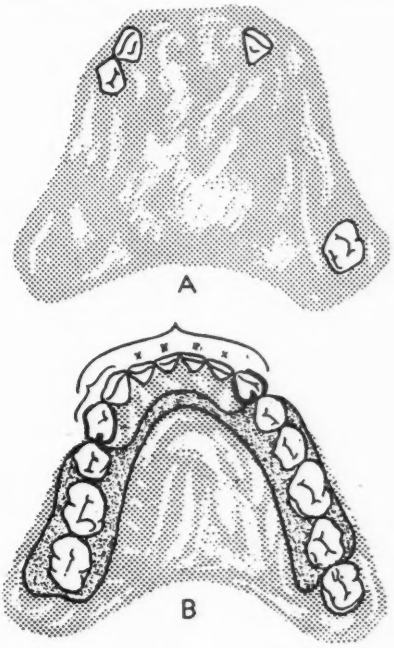

Fig. 6.—*A:* Lower case in which a cuspid and a bicuspid remain on one side and a cuspid and third molar on the other. *B:* Restoration of case shown in *A*.

When it has been determined what teeth are to be used as abutments, our

next consideration is the type of abutment to be used.

3. *Operative Procedure.*—Where a bicuspid is badly broken down, porcelain jackets, or combination gold and porcelain jackets, fill the requirements. On molars in the same condition, porcelain or gold jacket crowns can be used, preferably the latter, because of possible breakage of the porcelain in this region. Three-quarter crowns are applicable on molars and bicuspids when we have considerable tooth destruction but a sound buccal plate remaining.

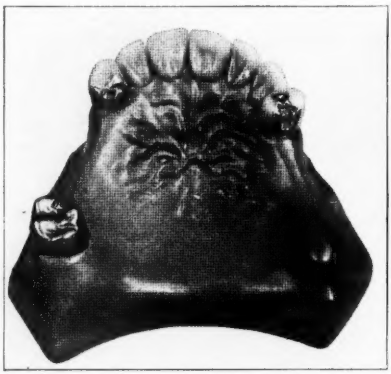

Fig. 7.—Case illustrating technic employed in types of abutments used in this particular restoration.

On the lower first bicuspids, the opportunity for placing a clasp is oftentimes made difficult by reason of the fact that the lingual cusp is very short, scarcely protruding above the gingival margin. In these cases, the three-quarter attachment is indicated in order that the lingual surface may be lengthened, the cusps being built up until there is sufficient area exposed from cusp to gingiva to afford the proper grip on such tooth.

This completes the diagnosis, from which we now determine what is necessary in the case in hand in the way of preparation of abutments. If we have otherwise good teeth and sound enamel to deal with, and there is no predisposition toward gingival decay, an inlay is generally all that is necessary in the way of tooth preparation.

I am aware of the fact that, when we have sound teeth, many men hesitate to do or do not do anything in the way of operative procedure, allowing the upright standard and their clasps to project into the interproximal space, the lug resting on the marginal ridge and

Fig. 8.—Method of paralleling the essentials.

carrying over onto the occlusal surface.

I cannot agree with such practice. My reason for employing a simple distoclusal or mesioclusal inlay, as the case may require, is that I deem a strong lug resting in the marginal ridge of prime importance to a successful result. And I have no use for a lug that lies above the marginal ridge, occupying the place that is necessary for the reception of the cusps of the opposing teeth.

We dwell on tooth structure in opera-

tive dentistry and in crowns and bridgework, and then destroy all such chance of a successful structure by superimposing a lug of gold on an occlusal surface, projecting into space; which, as I have stated before, should be used for other purposes. My contention is that lugs and the upright standard connecting them with a clasp should be buried within the confines of that tooth.

I grant that, in a number of these cases, teeth, owing to extraction, are so tipped out of alinement that the marginal ridges in question do not come in contact with the opposing teeth; but my position is that the argument does not

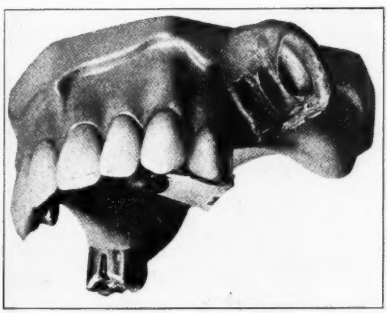

Fig. 9.—Technic for individual tooth impressions.

hold good under these conditions, because all such teeth, so out of alinement, should have the occlusal surfaces reconstructed to occlude properly before further restoration is attempted.

Figure 7 illustrates our technic. All of the teeth are missing posteriorly to the first bicuspid on one side and between the cuspid and second molar on the opposite side. The first bicuspid in question is a sound tooth, or at least one with the buccal and lingual surfaces intact. Operative work on this tooth does not call for anything more than a distoclusal inlay. In the cuspid, we place a distal inlay of large enough proportions to accommodate a large socket; while a full gold jacket crown is placed on the molar.

When the abutments are completed, the necessary step before their cementation is to place them in the mouth and take an impression, remove and place in the impression, and transfer to a model. From this model, we determine just where the upright standards and occlusal lugs are to be placed, and prepare such surfaces for their reception, making slots on such surfaces as are to receive the upright standards parallel with each other, as illustrated in Figure 8, and deep enough into the abutment that they will be flush with the periphery of the tooth

Fig. 10.—Various steps in clasp construction.

when placed in position. If the abutments are full crowns, the clasp can be completed on them. In the event that they are inlays or three-quarter crowns, such abutments are cemented to place and finished.

Impressions are then taken of the teeth carrying these abutments, with partial trays (Fig. 9), which are made of sheet aluminum so shaped that the tray will take the occlusal, lingual and approximal surfaces in question, the buccal being taken with a flat piece of metal carrying a sufficient amount of compound for that surface.

The technic for this impression is as follows: A small amount of black com-

pound is placed in the first tray, softened and pressed home, the buccal surface being supplied with finger pressure. It is removed, and if the detail is perfect, it is trimmed away on the entire buccal surface and placed back on the tooth, a

Fig. 11.—Type of tray used for taking modeling compound impressions.

well defined, sharp outline of the joint being afforded between the modeling compound and tooth surface.

This is now lubricated and the compound carried on a flat piece of metal and forced against the buccal surface. In the meantime, the first section is held firmly in position, and then chilled. Each section is now removed, separately dried and assembled, invested in plaster and packed with either model alloy or copper amalgam, preferably the latter.

Should any difficulty be encountered in obtaining the detail necessary with the one compound, a small amount of

Fig. 12.—*A:* Basic impression made of block compound. *B:* Completed impression, showing thin layer of red compound forced home under pressure of basic impression.

red compound dropped from the heated point of the stick into the basal impression will be easily driven home under force of such a basal impression, and fine detail be obtained. From this model, which is as nearly an exact replica of the tooth as we can obtain, a correctly fitting clasp is constructed.

A bicuspid calls for an upright and

lug of at least 12-gage half-round wire; a molar, a heavier wire, 10 or 11 gage. The upright standards, owing to the fact that they are sunk within the confines of the tooth surface, must be parallel with each other. This paralleling is accomplished by the use of the paralleling device.

There are reasons for so placing the upright and lug other than merely having the occlusal lug even with the marginal ridge: the upright, so placed, does not interfere with the first tooth supplied on our denture; in other words, it can be brought into contact, that is, to proper position, with the abutment tooth;

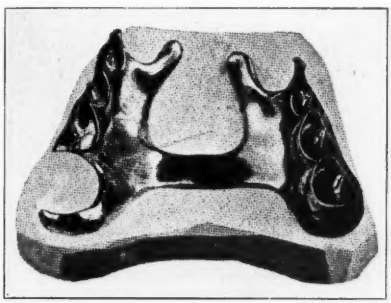

Fig. 13.—Check model of saddles and bar only.

and these two or more sunken uprights, parallel with each other, afford a stabilizing influence for the entire case. The balance of the clasp is completed with 13 or 14 half-round wire, so shaped that it is properly conformed to the tooth surface and does not approach the gingival tissue.

Figure 10 illustrates the technic of clasp construction, showing the groove and socket on the mesial and occlusal surface, and the half-round wire from which we cut a three cornered section with a jeweler's saw, so that we may bend it at right angles and solder in this position. It is now cut to proper length and fitted to its position in the crown, the clasp being soldered to it, as illustrated. Figure 10 also shows a finished clasp of the same type.

There are certain cases in which the teeth are slightly out of alinement, and, in order to know that our completed case will go to place without having to be sprung to position, which is a serious strain on the abutting teeth in question, tending to produce an inflammatory state in their sockets, we must take an added impression and mount all crowns and models of individual teeth for the

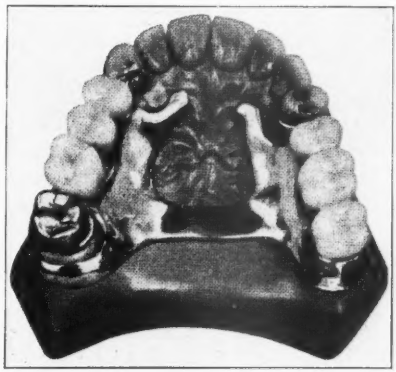

Fig. 14.—Completion of case to point of assembling clasps.

alinement of such clasps, so that we can rest assured that the case, on its completion, will slip to place without the abutments' being subjected to undue strain.

We are now ready for one of the most important steps in the case, and that is the impression on which we build our case. The clasps are not placed on the teeth while that impression is being taken. For the impression, we use modeling compound entirely, plaster not being indicated, according to our views, in any partial denture construction, nor any

other material used in such a way that we do not have a certain amount of pressure exerted that will displace the soft tissues. In order to obtain this result, two different kinds of compound are used, but they are not mixed together, for the reason that compound will not displace the soft tissues any more than plaster of Paris, if it is heated to the same consistency throughout its entire bulk.

For the impression tray, partial denture No. 5 is used, as illustrated in Figure 12. The tray is now trimmed to fit the case. Should the case be a lower, be certain that the heel is so elevated as not to impinge on the tissue in the posterior region. Black compound is used for the

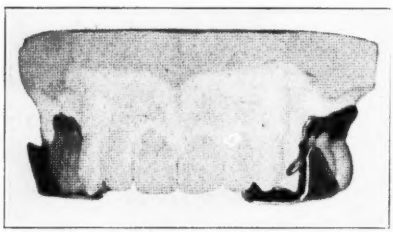

Fig. 15.—Method of attaching small trays to occlusal surfaces of supplied teeth in contact with abutments.

basal impression, being forced home, and, while still in a moldable state, moved from side to side to increase the size of the openings of the various teeth included in the impression. (Fig. 12*A*.)

The impression is now removed from the mouth and generously trimmed until the labial and buccal surfaces of all teeth anterior to the space occupied by the replacement are exposed almost to their incisal ends. The surplus is trimmed away on the buccal and lingual surfaces until free muscular movement is accomplished, and absolute freedom assured the tongue.

Should there be posterior teeth back of which the case does not extend, all compound is trimmed from the lingual and buccal surfaces, leaving merely the occlusal and mesial surfaces of such teeth covered by the impression.

This basal impression tray, into which it now resolves itself, is thoroughly chilled and dried. A thin layer of compound is now heated and pressed to place over the entire surface of the basal impression (Fig. 12*B*), passed over the flame until thoroughly softened, dipped into water of approximately 160 degrees and forced home under pressure, the teeth having been previously oiled thoroughly.

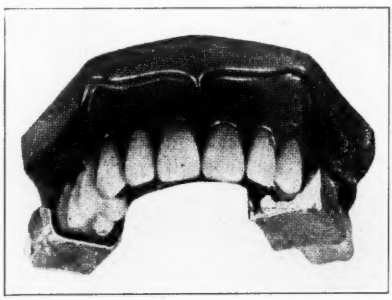

Fig. 16.—Illustrating individual trays taking impressions of clasps in their proper positions in the mouth, with thin plaster of Paris as an impression medium.

All cheek muscles are raised and lowered, and the patient is instructed to force the tongue as far out of the mouth as possible, should the case be a lower. The modeling compound is allowed almost to set, when it is raised about half the length of the teeth from its position, and then reseated. This operation is repeated three or four times, until we are certain all undercuts are removed. It is now chilled with cold water and raised slightly so that the cold water may be

forced under, and the impression is forced immediately back to position and then removed.

In many cases, a face-piece is not necessary, but should one be desired, compound is now trimmed on the exposed labial surface, until, when placed back in the mouth, the impression meets the tooth with a well-defined sharp line. All surfaces are oiled and the face-piece is taken with a core of compound. The case is removed and thoroughly washed with cold water and soap in order to remove all traces of oil.

An impression taken in this manner will give a model with all undercuts removed, which is something to be desired. A removable denture should find its position without having to take into consideration such difficulties as undercuts, and it is a self-evident fact that, in a properly taken impression, with modeling compound as an impression medium, that can be removed and replaced, the denture finished upon a model poured in such an impression will do likewise in the mouth.

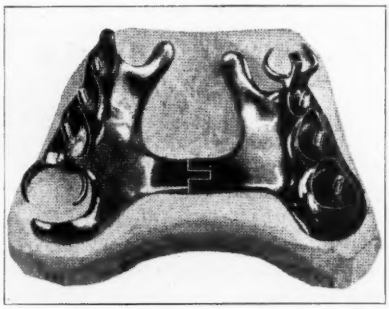

Fig. 17.—Finished case placed on check model to verify its correctness. This illustration also shows the author's method of bar construction.

Such teeth as are to carry simple rest lugs are packed with amalgam in order to retain a definite model of the sockets which have been prepared in their marginal ridges, the balance of the model being run in artificial stone. Modeling compound bite-blocks are prepared and the jaw relation is taken.

These bite-blocks should be carefully conformed to the model, fitting closely to the abutment teeth, so as to give it stability when it is placed in position in the mouth, and trimmed on the occlusal surfaces so that the upper and lower jaws will lack about 2 mm. of closure.

The occlusal surfaces are now softened by passing over the flame, until this entire surface will offer nothing in the way of resistance. The model is placed in the mouth, firmly in position, and the patient is instructed to close the jaws. This position is held until the compound is fully chilled. The bites are now removed and the surplus compound is trimmed away until merely the imprints of the opposing cusps are left.

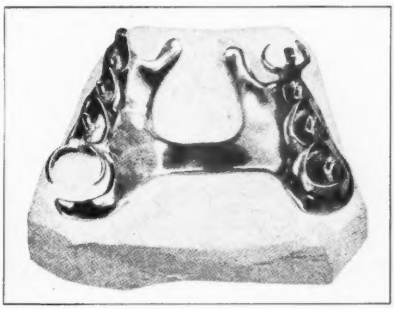

Fig. 18.—Completed case seated on check model before being placed in the mouth.

When the casts are assembled in position on these bite-blocks, the case will be opened to the point where the teeth will have to be built to proper occlusion when the finished case is again seated in the mouth. The models are

now mounted on an instrument. The clasps are placed in their approximate positions, and, with a pencil, the periphery of the case is outlined on the cast, indirect retention being indicated, if it should be used; hard spots on the mouth that must be built up with tin foil, and other peculiarities of construction that the individual case may call for.

The construction is now completed up to the point of attachment of the clasps, which is never accomplished on the model on which the case is made, by reason of the fact that all cases assume a different position on the mucosa than they do on the model.

I do not believe it possible to cast a saddle and clasp in one operation and not produce something of an orthodontic appliance by so doing. In other words, if we place the clasps in their position in the mouth and taken an impression; remove the clasps and accurately place them in the impression; run the model, and then make the case without soldering the clasps to the case, but transfer them to the mouth, take a relationship impression and solder the clasps to the case upon a model so obtained, it is well nigh impossible to place that case back on the model; because, as I have stated before, the saddle assumes a different position in the mouth from that it had on the model.

When the case is completed up to the point where we are to take the relationship impression of clasp to saddle, a check model is made of the saddles and bar only. (Fig. 13.)

Figure 14 illustrates completion of the case to the point of assembling the clasps. It is a difficult matter to place clasps in the mouth and steady the case as it should be steadied, and take a relationship impression at the same time. However, this has been reduced to a simple operation by making an impression tray out of the case. (Fig. 15.) This is accomplished by cutting a piece of sheet aluminum large enough to cover the occlusal surface of the first supplied tooth and the tooth carrying the clasps, having flanges bent over the lingual and buccal surfaces, reaching down to the clasps.

The porcelain teeth are now waxed solidly to the gold saddle, and these small metal trays waxed to the occlusal surface of the first supplied tooth next to the tooth carrying the clasp. These trays are waxed to every point where a clasp is to be soldered. (Fig. 16.) Thin plaster with a slight amount of hardener is now placed in these various small trays and carried to position in the mouth.

Standing in a convenient position with the balls of the first two fingers resting midway on the occlusal surface of the porcelain supplied teeth, the operator exerts sufficient pressure to seat the saddles firmly in position without blanching the mucosa. When I say firmly, I am using a relative term, because I recognize that we have two distinct seatings of the saddle on the mucosa, in different positions: the rest and the masticatory position. The rest position is the position we must have when the clasps are soldered to the case. The masticatory position will be dealt with later.

The clasps are now removed, placed in their respective positions in the impression, transferred to the model and soldered. In a large percentage of cases, we have distortion following the operation of soldering the clasps to position, not at the point where the clasps are soldered, but a warpage in the over-arch bar, if an upper, or in the lingual bar, if a lower.

To determine whether such warpage has taken place, we place the case back on the check model. (Fig. 17.) Should there be the slightest distortion, the case will rock on this model, and it is necessary that it be unsoldered in the center of the bar and resoldered until any rocking has entirely disappeared. Figure 17 also illustrates the dovetailing procedure of our bar construction.

Figure 18 illustrates the finished case seated on the check model. These check models are filed away for reference, and in case of the denture's being dropped, or in some other manner distorted, it can be placed back on the model, and such distortion corrected, in the majority of cases without reference to the patient. If the patient should return with sore spots on the mucosa, the first step in determining where the trouble may be is to place the case back on the check model. Should no rocking be present, look to the occlusion, for, in the majority of cases, the trouble will be found there rather than in the adaptation of the saddle.

Of utmost importance to the successful outcome of any case is the occlusion, which cannot be finally adjusted until the case is fully completed and placed in the mouth. Carbon paper is used to detect high spots and incorrect occlusal planes. These areas are corrected by spot grinding. In practically all cases, we find it necessary to correct certain occlusal planes on the abutments and other remaining teeth. The final correction is made by means of a grinding paste, which is placed on the occlusal surfaces of all the teeth in the mouth, the milling being done by the patients themselves.

The position under occlusal pressure, as in mastication, is one which, by reason of having sufficient rest lugs and as many points of suspension as we can have in the case, coupled with the extension of the saddles over the surfaces of the investing tissue overlying the various abutments, gives the massaging necessary for the stimulation of such tissues, which tends to a healthy condition of these abutting teeth, as Dr. Chayes has brought to our attention.

Under this occlusal pressure, as in the act of mastication, we have the blanching of tissues underlying the saddles; which I believe compensates for the sinking of the roots of the abutments into the peridental membrane. On the release of such pressure, the teeth come back to their position, and the rest lugs bring the saddles back to their rest position.

This stimulation, when the stress is borne by both the teeth and the mucosa, tends to develop the tissue rather than absorb it, and provided the occlusion is correct, the teeth supporting the clasps will remain firm in their positions. In many instances, when such teeth have become loosened through nonsupport, they have become firm under the bearing of a clasp.

When a case is first inserted, I have the clasps fitted snugly, gripping the abutments so tightly that the patient can scarcely remove them, for the reason that we are inserting something entirely foreign to the mouth, and the patient will become accustomed to it in a much shorter time if it is held in rigid position.

For the first three or four days, I see the patient daily myself to remove and clean the denture. By the end of this time, the clasps have milled themselves on, so to speak, to the teeth to which they are fitted, and as the patient becomes more accustomed to the presence of the denture, he can wear it without such a

tense grip on the teeth, the clasps merely acting as a stabilizing influence without much tension.

Individual movement of the teeth is very slight, and for this reason, there are few cases in which I apply the principle of broken stress any more than a properly fitted clasp will allow.

Spring wires and all such appliances are easily gotten out of position. The patient will wear them because, owing to their flexibility, he can place the case in the mouth. However, damage is many times done to the investing tissue surrounding abutments by reason of such wear, before we have the opportunity of correcting the condition.

DISCUSSION

Roy James Rinehart, Kansas City, Mo.: Partial dentures have been used all along the pathway of supplying missing members in the dental arch, but many of the contrivances placed in the mouth have been failures and many of them damaging. Dr. Tinker has presented to us an exact technic for the fitting of the rests and the making of the clasp which, I believe, if properly carried out, will prove very serviceable indeed. Accuracy of technic is to be desired in the practices of most dentists. Much of the work which has been done in the past has been lacking in proper engineering principles. When the case described in this paper is completed, the standards and lugs will fit into the crown or inlay preparations in an absolutely accurate manner, and there is no way for them to slip out of place unless the case became so distorted that the patient could not wear it. The description of the case seems to insure continued occlusion, and if Dr. Tinker is correct in his statement regarding the massage of the gums and the extra use of the teeth as being beneficial rather than detrimental—and I believe that he is—we have in this paper a valuable contribution to dental technic. Many of the partial cases being constructed today are one-piece castings with clasps round the enamel and lugs on the marginal ridge. It cannot be denied that this will abrade the teeth to a considerable extent and that the lugs will be very detrimental to the enamel structure of the teeth. Many years ago, it was customary to crown a tooth around which clasps were constructed, and I have observed over many years of practice that these cases withstood the test of time. In recent years, we have fallen away from this custom, for the reason that the placing of gold crowns, for a time at least, was in the class of questionable dental procedure. It is my opinion that the accurate fitting of crowns should never have been so classified. I desire at this place to speak of the unfortunate condition which exists among some members of the medical profession who persist in condemning all teeth wearing gold crowns. I have heard much of this argument and have made some observations in my own practice, but I did not realize that so many physicians were of this opinion until some recent experiences proved to me that the views held by the medical men in this regard constitute a serious problem. At a recent meeting of physicians of the United States, Canada and several foreign countries in Kansas City, several of the men visited our dental school, and I was asked as to whether or not the school approved of gold crowns. My answer was, "Most certainly, when they are indicated and properly constructed." I then asked their attitude in this connection and was informed that when they had a patient with gold crowns in the mouth, they ordered them out. Closer cooperation and a better understanding should exist between the two professions in order that such grave conditions as this may have attention. Physicians have ordered the extraction of gold crowns when, in the same mouth, there were partial gold crowns and porcelain jacket crowns, the latter probably showing a more serious condition of focal infection than the tooth bearing the gold crown.

W. E. Cummer, Toronto, Canada.: It is impossible for me to view the subject of partial denture service, including science and practice, in any other light than as a problem in engineering (that is, after actual disease conditions are diagnosed and disposed of). Engineering is a sister profession which is quite as noble as the sister profession of medicine, in its contribution to the welfare of the human race. So, to engineering we may well look for precedent in our efforts to restore normal structure and function; using such parts of her vast science and practice, developed through

centuries of experience with fabricated structures and mechanisms of all varieties and magnitudes, as will assist us in our problems. But there is this essential difference: dental engineering must be governed by biologic laws which are basic to the health of the living oral structures and functions, of which we, as dental engineers, must ask extra duty in the way of support and retention for our artificial restorations, as well as the necessary change to the normal environment of these living structures and functions due to the presence of our artificial appliances, even though they may be designed and constructed after the highest standards of practice. So I trust that I shall be pardoned if I choose a single word, which I shall quote later, which has crept into Dr. Tinker's paper, in all probability quite by accident. To me, this word is an index of what seems to be a lack of appreciation on the part of a large part of our profession (but certainly not Dr. Tinker) of the enormous value of the principles and practice of engineering which are applicable to many phases of dentistry, and perhaps above all, to partial denture service. And, after all, this is quite natural, in view of the prominent place now given, even on our research programs, to biology and medicine, to the total exclusion of engineering in dentistry. The practice of engineering, relating to construction work, almost invariably proceeds in five stages, namely, (1) preliminary examination and study of the related facts and circumstances; (2) design; (3) construction; (4) installation, and (5) maintenance and repair. Apply this, if you will, to the genesis of any example of the enormous range of engineering construction, say, for example, a great ocean liner; the latest model of your favorite motor car; the stately basilica, and, finally, the tiny antithesis of all of these, a partial denture. So that, as dental engineers, we must learn, not only to think, but also to speak as engineers; and, in partial denture service, after the preliminary study and examination are completed, and all disease is diagnosed and the parts involved are brought to a state of health, the problem now ceases to be a problem in dental medicine or dental surgery and becomes a problem in dental engineering. Then, I would submit that, in describing the next step, namely, the planning or designing of the future artificial restoration, it would help us all to think as dental engineers, if the term "diagnosis," the offending word referred to above, which belongs to medicine and has to do with identifying disease, were dropped, and an engineering term, as for example designing or planning, might well, during the remainder of the service, be adopted in its place. We may well glory in the fact that dentistry requires the qualities of a dentist, in addition to certain qualities of a practitioner of medicine, a surgeon, an artist and, finally, an engineer. And the day must come in which dental research, that unerring index of the future of a profession, will not mean only as now, the microscope and test tube of the dental biologist, but also the gnathodynamometer, the measurements, calculations and formulas of the dental engineer. I shall therefore discuss Dr. Tinker's subject under the five heads just mentioned: preliminary examination; design; construction; installation; maintenance, and repair. I am in full accord with Dr. Tinker in the matter of a full roentgenographic examination, a limited degree of surgery where indicated, the removal of sound teeth where their retention and its advantages are offset by disadvantageous design and construction, and the use of a temporary denture (which I assume may be later reconstructed into a spare denture) and the use of mounted or unmounted study casts, this depending on the degree of intricacy of the case. Under the head "design," I offer what I feel to be constructive criticism on three aspects, namely, retention, the manner of occlusal support, and a phase of denture outline. Dr. Roach, I believe, first brought forth the principle of indirect retention, using the mucosa for the indirect contact for the use of the dental profession. It might be well to add that Dr. Roach soon found that a flat type of vault, and not an arched type, is essential for success in this instance, for obvious reasons. Assuming a three arm clasp on the upper left bicuspid, described in the text, and that the three extensions on the denture outline are intended for indirect retention, I am quite unable to see their retentive value. If a dotted line is drawn between the direct retainers, as suggested by Prothero and called by him the fulcrum line in his classic on prosthetic dentistry, it will be seen that, on the distal side of this line, the saddle, which is of considerable area, provides ample balance, without the single extension around the distal side of the right molar. On the mesial side

of the fulcrum line, the cuspid occlusal rest or lug, which is recessed into an inlay, provides a positive balance or indirect retention, in which the two extensions of the saddle in a mesial direction appear to be unnecessary. I recommend this use of the fulcrum line as of great value in determining indirect retention or balance; and will therefore conclude that these extensions are intended for massage purposes, after Chayes, to which Dr. Tinker makes reference. But even this explanation does not exactly seem to suffice; for a line representing the rotation axis of the denture, drawn between the posterior lugs, shows the right extension as probably receiving an intermittent depression, with the left saddle during masticating strokes; but it would seem that both anterior extensions would intermittently rise away from the mucosa rather than be depressed into it, during the masticating strokes. Referring to the left side, in which six occlusal surfaces appear at first glance to be carried by two roots, and one of these a lateral incisor and which seems an apparent overload, it will be remembered that, under the head of construction, Dr. Tinker has described at length his exacting technic in which the occlusal rests or lugs are so adjusted that the mucosa receives the load up to a predetermined limit. In this predetermined limit, the mucosa is described as compressed, but not blanched, after which the teeth, with the mucosa, assume the further load given by the muscle traction; so that, after all, no overload exists under these circumstances. Should absorption occur beneath this saddle, the entire load would fall upon the molar and lateral incisor, and overloading would probably occur, unless the muscle traction were extremely light. An alternative design for this case, which would be somewhat less capable of carrying incision loads, but with practically the same capability of carrying loads on the posterior teeth, involving considerably less technical work, and with it lower costs, and eliminating the danger of the overload described above, would be the same design, without the lateral inlays and rests, and, if possible, surface occlusal rests with connectors in the embrasures, on the molars. Being, then, a type of combination support with the mesial end mucosa support, and the distal end-root support, provision must be made for rotation. All of this points to the need of a type of dental engineering research, in which a gnathodynamometer is evolved, capable of measuring loads of mastication and registering deflections under these loads, applied to a sufficient number and variety of conditions, as the foregoing, until a definite formula evolves as to the loads various combinations of teeth and their adjacent spaces of mucosa are capable of carrying with safety. The practice of modern engineering would be impossible without formulas somewhat similar to that outlined above; and with such a piece of research completed, the future dental engineer, with this definite information, modified by a suitable biologic index to fit the different capabilities of the tissues involved peculiar to each patient, would be enabled, without difficulty, to allot these loads to a nicety. And then empiricism, conjecture, opinion, and plain guess would be replaced by a scientific determination of this, perhaps the most difficult of all problems associated with partial denture service, namely, the loading problem. In each case were the right molars chosen for the retaining teeth, a fulcrum line would then show the denture in better balance. Clasps with more resilient arms, and with a lighter grasp, would give the same retention, and, with it, there would be less probability of trauma and less inhibition of individual tooth movement. There are a number of reasons why I am unable to concur with the contention of Dr. Tinker, if understood aright, that all occlusal rests, with their connectors, should be recessed into inlays or crowns. Should these inlays or crowns be already required, or made to replace others already in position, no serious loss of tooth substance or effort will be involved. Therefore, I propose the following arguments in support of the common form of occlusal rest which curves over the marginal ridge, with its connector located in the embrasure, assuming in each case good design and construction. 1. Simplicity and economy in construction, which means lower costs; so that the partial denture service comes into the range of the capabilities of a larger number of dentists and their technicians, and is hence available for a larger number of semi-edentulous persons to whom costs are a consideration. 2. Lack of interference with the saliva flow from side to side through the interproximal spaces. 3. A contact between the natural and artificial teeth which is fairly similar to natural conditions. 4. Advantages of structure. While it is quite true

that the natural contours of the occlusal surfaces are not reproduced with absolute fidelity, an area of approximately 3 square millimeters only is affected by the surface occlusal rest in its ordinary form; and then but slightly. Artificial teeth never did faithfully reproduce natural teeth; and, lately, some types of artificial teeth which embody the latest studies of their designers are less similar to natural teeth than ever before as, for example, Gysi cross-bite teeth, Sears channel teeth, and Professor Schroeder's mortar and pestle teeth. 5. Conservation of tooth tissue. 6. Freedom from possibility of torque in a correct surface occlusal rest. There is no implication that there is torque in any of the cases shown, but it might occur if the compression of the mucosa on the masticating stroke of the mandible were not anticipated, and if no allowance were made in the fit of the connector in the slot to permit, without interference, the resulting movement of the saddle. Regarding impression methods, I hope that future research will bring forth suitable methods which will give a cast reproducing relations with the mucosa under pressure, and thus eliminating the additional effort and skill required in assembling the parts of the restoration by additional impressions as described by Dr. Tinker. This again would tend to bring this type of work within the range of a larger number of semi-edentulous persons. As regards occlusion, accurate reproduction of the characteristic mandibular movements with the movements of the planes of each artificial tooth in harmony with the planes of the remaining natural teeth in the finished piece is here of supreme importance; for any interference is reflected to the clasped teeth, to their injury and probable destruction. Referring to partial denture service only, at the present time the principle of three point balance, as developed by Rupert E. Hall, and embodied in the instrument which bears his name and also the instrument of Stansbery, points the way toward a time when, after the completion of a partial denture, every plane, natural and artificial, will function with no interference, requiring little or no spot grinding, with perhaps a final grinding in, in the mouth, with abrasive paste.

Dr. Tinker (closing): I wish to refer to the use of gold crowns as abutments for teeth that are to be clasped. I will say that I am perfectly willing to admit that I use more gold crowns today than I have since the advent of casting. I have no hesitancy, in fact, I would hesitate to use anything else on a molar tooth, unless I was practically certain that the condition of my patient was just about 100 per cent, as far as mouth prophylaxis is concerned. It is a disheartening thing to construct a beautiful case with a three-quarter crown or an inlay as a restoration, and have the patient return in a short space of time with a line of decay extending over that portion of the tooth which is in contact with the clasp. These things happen with the best of us in such a large percentage of cases that I, for one, am crowning molar teeth in practically all my restorations, whether fixed or removable. I realize that engineering enters into this field. We have to study these cases from many different angles, but whether or not the term engineering is the proper one, I am not prepared to say, by reason of the fact that engineering is an exact science and does not enter into the treatment of disease or its repair. An engineer is able to figure absolutely the basis or foundation upon which he starts his work. He can make his foundations or his footing capable of carrying the weight of his superstructure. But we, as dentists, must accept the conditions as we find them and build the best structures possible from such conditions. It is true that we must take cognizance of the laws of leverages, and also compute a division of bearing between the soft and hard tissues, and other conditions as they come up in the study of our various cases. I regard partial dentures as a means of treatment in restoring lost functions of the mouth. They are developed from our diagnosis, and until I am convinced that I am wrong, I shall retain the term "diagnosis."

THE EFFECT OF UNRELIABLE METALLURGIC DATA ON THE PRACTICE OF DENTISTRY*

By MARCUS L. WARD, Ann Arbor, Mich.

WHEN your committee requested me to discuss some phase of metallurgy about a year ago, nothing definite on this large and undeveloped subject was suggested. Since the invitation seemed to be the result of some discussions which took place at the Illinois State Meeting at Peoria, and since the metallurgy relating to the different uses for casting was under discussion there, it has been assumed that a renewal of the discussion here would be agreeable.

As I have given the subject more definite attention with a view to its presentation, it has become more and more difficult to determine whether to discuss only some of the metallurgy connected with casting or to include some of the related subjects which appear to be in as much need of clarification as the subject of casting does. The conflicting emphasis which is being placed on the necessity to expand waxes in order to get good inlays, and the frequent appearance on society programs of clinicians demonstrating one piece partial dentures, implies very strongly that the presentation of metallurgic data alone is not sufficient to bring about a better understanding. It implies that there is a condition of tolerance and, in some cases, cordiality in the profession which is not justifiable on the basis of what we really know, for things which are in many instances little more than "stunts."

If clinicians were criticized by the dentists for the presentation of some of these "stunts," the latter would soon become less popular and consequently less confusing to many practitioners who do not realize that the presentation of a stunt is often, if not usually, an unconscious confession of a narrow understanding of the subject with which the stunt is associated. As it is, some of these clinicians have been paid good fees for their presentations, have represented supply houses or had something of their own to sell, have criticized some of the best teaching talent that dentistry has developed, and have given practitioners who may have been among the profession's best public servants the impression that they were out of date if they did not adopt the methods that were being presented. In other words, some of these clinicians have been sought, welcomed, paid and idolized to present some method of practice in stunt fashion. My intention is not to discredit all stunts, for it is sometimes possible to use some short cuts to successful practice which might be well designated as stunts, but the presentation of a stunt along with some unrelated big sounding words as the latest and most scientific method is not often constructive work. It is more likely to be disturbing to the practitioner who does not at the time recognize it as a stunt,

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and it makes more work for the conscientious teacher who tries to keep his work on a sound basis.

On account of this situation, which involves several other things related to casting, it has seemed best to point out some of the unreliable data that are disturbing to both practitioners and teachers and some of the reasons for the cordial reception by the profession of some of these stunt clinicians, who may be found in both the professional and the manufacturing fields. This will, of course, necessitate an omission of some detailed data relating to casting, but until the profession has become tired of stunts, there is little advantage in the presentation of detailed facts, as can be shown by the records at the present time.

It will require little effort on the part of those interested to learn the fundamental reason for this condition, but it will require much study and effort to correct it. It is, briefly stated, because dentistry has grown from practically nothing to a profession of which we are all proud, in the shortest time that a profession has ever developed, against the greatest odds that any profession ever encountered and with the least support from educational institutions that was ever given to one of the professions, with our eyes focused on the task of proving with biologic data the value of dentistry as a health service. In our efforts to do so, we have not kept pace in our development with the developments in engineering, and yet some of our health service is dependent on the construction of some of the most complicated appliances which were ever made in engineering. The subject of physics has only very recently been included in the required education of dentists, and the application of many principles of physics to mechanics, as has been in practice for a long time in engineering, has been begun in only one or two places in this country. It has been said many times that the modern practice of medicine began with Pasteur's presentation of the germ theory in 1857, and this has probably been true up to this time. With some of the developments in biologic chemistry that are now being made known, the situation becomes somewhat different, and it is difficult to say what will mark the beginning of the modern practice of medicine in another generation. Physics, and especially that part which relates to electricity, is playing such a part in our scientific development, especially in chemistry, both in inorganic and organic relationships, that almost anything may be expected in another generation.

Much of the same thing that was said about medicine may be said about the beginning of the modern practice of dentistry. When, between the years 1910 and 1920, quite definite evidence was being presented to prove the contentions that dentists had made for several decades, that infection in the teeth and the mouth were as much related to the problem of health as were infections in other parts of the body, physicians, educators and laymen alike were appalled that some of these facts had not been developed sooner. At once, dentistry received the recognition that had been accorded many of the other branches of learning, and a study was begun. The results of the study confirm the claims of dentists to recognition in health programs, and the educational institutions of the country have become interested, physicians are cooperating with dentists and the public is becoming awakened.

It will not be at all strange, therefore, if, in another generation, it is claimed that the modern practice of den-

tistry began with the germ theory between the years 1910 and 1920, when it was demonstrated that bacteria in the teeth and the mouth played an important part in the matter of health.

This is as it probably should be; for as long as bacteriology and its related sciences form the foundation of the practice of medicine, they must also form the foundation for the practice of dentistry. We must not forget, however, that in order to keep the germ theory as the foundation of the practice of dentistry and maintain the respect of educated persons, we cannot be biologically scientific and metallurgically unsound. We must have at least a general knowledge of the subject so that there may be brought into the construction and application of many of our restorations a physical and mechanical accuracy which will compare favorably with our bacteriologic accuracy. It is rapidly becoming more difficult for a clinician or essayist to make empiric statements about bacteriology and pathology without being challenged immediately, but one may make almost any kind of statement about metallurgy, or what is regarded as scientific mechanics, and go unchallenged. Up to this time, there has been little recognition on the part of dentistry of the value of a knowledge of physics and metallurgy whenever anything mechanical is to be done. It has been customary in dental practice, and to some extent in the dental schools, to follow what appears to be the latest developments, without careful investigation, rather than the established principles of metallurgy and physics, until investigations could be made. A most interesting illustration of this kind may be found by observing the frequency with which dentists refer to the "so-called Akers' technic" for casting large restorations with Coe-4 gold and the number of manufacturers who market a casting gold for the same purpose with the number 4 associated in some way with the name. Some clever technicians demonstrated some time ago how some complicated large restorations could be made with Coe-4 gold, and the dentists, attracted by this casting stunt, adopted the alloy to such an extent that other manufacturers have found it necessary to make an alloy to compete with it in price and behavior and, in some instances, in name.

Judging from the other products of some of the reliable manufacturers, it would seem that they knew that this new product, which had apparently been forced on them, was not the best one, *all things* considered, with which to make large and complicated castings. There seems to be no reason to believe that well known manufacturers like White and Dee regard their alloys, identified by the number 4 and which belong to this class, as the best ones to use for making *clasps or lingual bars* that are subjected to alternating stresses. Neither is there reason to think that these manufacturers regard this class of alloys as the best with which to make the *saddle or palatal portion* of partial dentures, saddles, etc. They seem to make them to compete with the large sales of the Coe-4, which the advertising literature of the Coe laboratories claims was in the last three years 300,000 dwt. The popularity of this alloy seems to be due to its connection with one of these casting stunts, whereby complicated restorations were made in one piece rather than upon sound metallurgic principles of construction and upon the ability of this alloy to resist alternating stresses when made into clasps. In this instance, the profession did not investigate two essen-

tial phases of this work before it adopted it to such an extent that other manufacturers found it advisable to market a similar product. If the same process of thinking that is beginning to be applied to bacteriology and pathology were applied to this process of making restorations, not one-half inch in length as is the case with a large inlay, but two inches long as some of these partial plates and clasps may be, it probably would be found that it is a convenient thing that some of these dentures made in one piece be located in the vicinity of some loose teeth. Furthermore, if the profession would make the same demands on this class of alloys when they are making them into clasps *around* the teeth as is being made on rubber dam clamps and other instruments which are placed *around* the teeth, there would not have been 300,000 dwt. sold by one manufacturer in three years. Comparatively few have had the courage, in the face of the attractiveness of this clever casting stunt, to suggest that the same skill that has been applied to the one piece casting, if applied to the construction of a two or three or even four piece assembled restoration, might result in a better fitting, a more comfortable and less traumatic one. Furthermore, failure to ask a manufacturer whether his clasp metal will permit a clasp to be made which compares somewhat favorably with steel in its ability to be bent repeatedly is due to the profession's failure to think metallurgically. Between the lack of courage to question the soundness of the one piece large casting, and the failure to think metallurgically, two essential phases of the construction of this class of restorations have become so obscured that one hardly hears them mentioned. It may not be possible to develop an alloy which will remain untarnished in the mouth, be unobjectionable in color and unite readily with gold solders, and which will also permit of bending as many times without breaking as a steel clamp will, but there are some at the present time which, if handled in accordance with sound principles of casting and properly heat treated, offer such promise as to make a comparison with steel a logical procedure.

After having some unpleasant experiences with cast clasps, lingual bars, etc., in our clinics, a machine was constructed which would subject bars, which had been cast, and which were 1 mm. in thickness and 2 mm. in width, to a bend of twenty-five thousandths inch in one direction from a given center until they fatigued and broke. About every kind of irregularity was at once observed. Some of the first ones that we cast with the same melt of alloy would break at ten to twenty bendings, or flexes, while others cast at the same time with the same alloy would resist as high as five hundred. With improvements in the casting which would permit the metal to flow through a good sized opening into the mold and with more fixed conditions in cooling, we have recently made these bars with one of the four metal alloys, which have been bent from 200,000 to 600,000 times before they fatigued and broke. We have not been able to secure so great a uniformity as we should like to have, but there are other possibilities for improvement which we have not applied to this work and which may enable us to get the desired uniformity.

While we have probably only just begun the work, it would seem safe and perhaps advisable to present at least brief statements of our experiences over a period of about a year and a half, in trying to find a metal or alloy which would meet the requirements of our

clinics. When a specimen broke, one of the first things that we did in our work was to examine the broken ends. At once, we began to confirm the thing that we should naturally expect, that the number of times that the specimen bent before it broke was associated with a given structure. The uniformly fine-grained ones have invariably been better than the coarse ones, regardless of the composition. When we began this work, there was a notion in the minds of one or two manufacturers that an alloy with plenty of platinum or plenty of gold in it, or in which there was some iridium, must be good. It had not occurred to them that it was not intrinsic value that we wanted, but mainly resistance to repeated bendings. I have with me some mounted specimens showing the broken ends of one of these alloys which had a high platinum content, making it cost more than Coe-4, Dee-Four, White-Four or any other four with which we worked, but it would not resist, on an average, in our hands, as many bendings without fatiguing and breaking, as the so-called "four" golds would. Under the microscope, the structure of this high platinum content alloy, mounted along with some of the best ones that we have handled, might well be compared with the leaves of a palm tree and a Michigan maple. The structure is quite uniform, but the crystals have large facets which seem to make ideal cleavage lines when the specimens have been subjected to alternating stresses to the point of fatigue. Even though the profession has not had the advantage of the metallurgic training that the future seems to demand, it would seem that the old sales trick of calling alloys good because they are high carat gold, or platinum or anything else had about served its usefulness. Anyhow, some of the best manufacturers have taken this view of the matter, leaving some of the less well informed ones to follow this form of advertising.

As our work with clasp metals has proceeded, there have been a few things developing which, while they may not please some of the manufacturers of gold alloys and casting machines, should be stated at this time, notwithstanding the fact that our work is only nicely under way and, therefore, incomplete.

The first one is: The more simple the alloy, the more uniformly have we been able to cast it. The most simple alloys in the market for clasp metal work at the present time consist of the four metals: silver, gold, platinum and copper. The percentages are approximately: silver, 8 to 12; gold, 65 to 72; platinum, 5 to 10, and copper, 10 to 15.

It seems to be perfectly sound metallurgically that the simple alloys should behave more uniformly than those which are more complicated and which, as a result, present a greater number of possibilities for change in structure and behavior during the melting and the cooling process. Some of the most widely advertised alloys for one piece castings, clasps, lingual bars, etc., have been found to contain from five to seven metals, and in one conspicuous instance, the platinum had been entirely left out and nickel and zinc substituted. Any one who has examined the broken ends of large numbers of broken pieces of these clasp metal alloys will soon become convinced that one of the most important things connected with the manufacture of an alloy which is to be used for clasps, or anything else which is to be subjected to flexure, is to have it behave uniformly. It is not in the interest of the profession nor of the public to have in the hands of thousands of dentists who are attempt-

ing to render a good service materials which are, through no fault of the dentist, possessed of inherent qualities which make frequent failures a natural expectation. It is this latter phase of the situation which leads me to urge you to ask your dealer from now on which alloy for clasps will cast the most uniformly and will resist the greatest number of bendings, rather than to ask him if it will allow you to perform one of the one piece casting stunts. If you want to do some of these casting stunts, you had better get some type metal that printers use and keep your stunt in the laboratory rather than to get something that has some gold in it and try to mix it with your public service.

I have with me some of the specimens with which we have been working, and a low power microscope, and it would seem that only a few glances at them would convince you that one of the most important things to be demanded of an alloy which has to be flexed is that it have a uniformity in its behavior which will not disappoint you a large percentage of the time. There are exhibited, in the specimens which have been broken, evidences of segregation of the constituents, of occluded oxids, of a lack of uniformity of pressure during casting, and of the presence of large crystals unsuited to alloys which are frequently to be subjected to alternating stresses. There are also exhibited some with uniformly fine grains, with practically none of these objectionable features, which have shown great promise for the future of the cast clasp.

It seems, however, that we must distinguish quite clearly between what is most desirable in a clasp and in an inlay, for the casting of inlays has been occupying attention to such an extent lately that partial dentures, clasps, etc., have been going to the commercial laboratories, and the dentists, as a result, have not realized that what applied forcibly to the casting of an inlay may not apply so forcibly to the casting of a clasp, lingual bar or partial denture. The attention of the profession has been focused very largely lately on casting the inlay to dimensions, but our work would seem to indicate that the construction of clasps and other restorations will require that attention be focused on the structure, in order to safeguard the number of times which these restorations may be flexed.

In order that the structure may be suitable for appliances and restorations which have to be flexed, it appears to be strongly probable that some consideration will have to be given to the casting of clasps that may not have to be given to anything else. We shall unquestionably have to use every precaution against oxidation; we may have to use larger sprues and higher pressures, and we may find it advantageous to heat treat the completed restoration. With the inlay, there seems to be no such procedure necessary. It is at this point that I feel most uncertain about how much detail is necessary in order to stimulate a study of the casting process, with a view to a determination of the differences in the things to be accomplished. It is a common thing to have a casting regarded just as a casting, without reference to what can be done with it, notwithstanding practically every dentist is familiar with the tempering of steel instruments. Probably, nearly every dentist knows the difference in the behavior of a steel instrument which is straw color and of one which is blue, but only a few realize what structural changes are taking place when a piece of steel has been heated to redness and chilled and

then heated until the straw color and blue appear. He does not visualize the placing of a given number of constituents in a crucible for melting, and having different alloys exist at different temperatures. His metallurgic training has not been microscopic in nature and, as a result, he does not visualize the difference between the chilled and the blue or straw colored steel; nor does he understand what is being discussed when an attempt is made to show that a series of alloys of gold may exist at the melting point which may be broken up into others with different properties by subjecting these alloys to different degrees of heat after they have congealed. A manufacturer may produce the best alloy possible for a given purpose under conditions known only to him, but you can often convert it into something else in casting and cooling unless you know the right kind of technic and follow it. At the present time, only one manufacturer is known to me who has stated on the package what heat treatment to give his product, but if the dentists will give this matter the same attention that they are giving to their biologic work, they can compel each manufacturer to indicate on the package what the contents will do and how the desired result may be accomplished. As it is at present, the manufacturers have no pressure brought to bear on them by the profession to compel them to state what their product will do and how the result may be attained, and, therefore, some of the best informed manufacturers are the most confusing about their advertising.

As an example of this form of advertising, I suggest that you obtain a copy of the four-leaf post card sized folder of the S. S. White Company's advertisements of its casting golds. The White Company is chosen in this case, not because it is very different from some of the others in its advertising, but because of the standing of the company with the profession and because I was much surprised to see this form of advertising adopted by them. In this pamphlet of the White Company, there are twelve golds offered for sale by numbers running from 1 to 12. Recently, this pamphlet was shown to a group of our senior students, and they were requested to select golds from the list of twelve for three different purposes. A little later, the same experiment was tried on a group of dentists who were visiting my laboratory. In both instances, the words "White-Four for Akers' Technique" in large letters on the first page attracted the attention of almost every one of both groups. Almost unanimously, there was confusion about what the other eleven golds mentioned in the pamphlet were really intended to do. For example, gold inlay number 1 is said to be for hard dense inlays, while gold inlay number 2 is said to be for inlays to be burnished at the margins. It would seem to be implied that number 1 inlay gold was *not* to be burnished at the margins, but even the most inexperienced "ad" writer must know that all gold inlays should be burnished at the margins. The same uncertainty about what the manufacturer knows about his product is shown in other places in this pamphlet, and it is not at all strange that, as long as this condition exists, there is certain to be an equal amount of uncertainty about the value of the service rendered by the dentists who use these products. The outstanding emphasis in this pamphlet is placed on the introduction of a new product known as "White-Four." Some of the claims for this product are as follows:

The increasing popularity of the one piece

cast bridge or partial denture has stimulated the conscientious gold manufacturer to study intensively the available casting alloys, with a view to producing the best possible material for the techniques of Akers and others. White-Four is the happy result of systematic investigation in the S. S. White laboratories. It produces castings by the low heat method that, in every comparison we can make, surpass all other castings by this method.

Notwithstanding this claim that this new White-Four alloy will surpass all others that *they* have tried for this method, this company lists cast clasp gold number 6, which is said to be a "gold and platinum alloy for *perfect fitting clasps and lingual bars.*" It certainly would be interesting to know whether it is intended to imply that it is only once in a while that a dentist wants a clasp to fit perfectly, and, when he does, that he should use the number 6 alloy instead of the number 4 that is given three pages of mention against three lines for the number 6. There is also listed a number 7 cast clasp gold of gold color, a gold and platinum alloy that is said to be for cast clasps requiring a tough, hard and springy alloy. Is it intended that this number 7 alloy be used when a tough, hard and springy clasp is wanted; the number 6 alloy be used when one wants a clasp that fits perfectly, and the White-Four be used when one wants to make an Akers one piece casting? If this is what is intended, it would be interesting to know just what kind of restoration the one made from the White-Four into an Akers casting is. Does it *not* fit perfectly, or is it *not* tough, hard and springy? In one place in the pamphlet, it is stated that "Castings of White-Four made by men of the highest qualifications to pass judgment have been pronounced perfect in every detail of color, strength, density, toughness and resiliency." It may be noted that this advertisement does not say that the castings made from the White-Four alloy fit perfectly, nor that they *are* hard and springy, but it does say that they have been pronounced perfect in toughness and resiliency.

It would seem from these statements that, if this company knows any difference between these three alloys for clasps, it has concealed it in its confusing literature. There is little doubt that it intends to convey the idea that the White-Four is best suited to the construction of the Akers one piece casting. The most imaginative mind, however, will have difficulty in determining whether there is any difference between the number 4 and the numbers 6 and 7 when made into clasps, if a literal interpretation is to be placed on this advertising matter.

It has been stated that our most uniform results with these flexure tests have been secured with the alloys that did not contain more than four metals. Those containing five, six and seven, we have eliminated for the present, at least, from further consideration. We have also eliminated, to the same extent, those alloys in which, for the platinum, nickel and zinc have been substituted, on account of our inability to get uniformity in our results which would compare favorably with our results with other kinds of tests. Furthermore, we have abandoned temporarily all types of air pressure machines for our fatigue test work. Please do not misconstrue this statement as a condemnation of the air pressure machines for the casting of inlays and some of the smaller saddles, etc.; for we have made just as good as and perhaps a better average of inlays with air pressure than with the centrifugal machines.

The air pressure machines require a smaller sprue on account of the gold

lying over the mold, while the centrifugal machine will permit the use of almost any sized sprue. This one feature will, in some instances, permit the mold to be filled without the gold's being broken up into small masses, and being moved about in the mold as it is being filled. Furthermore, the pressure with the centrifugal machine is, with some, and may be with others, considerably higher than it is customary to use with the air pressure machines. There is another thing about the centrifugal machine that has been practically ignored in the presentation of the subject of casting by some of those who would apparently have us believe that they had solved the problems connected with casting. It is the difference in the heat applied to the mold during the melting of the gold. Some of those who have presented clinics on the subject of casting and have written emphatically about the accuracy of their technic, asserting that certain temperatures must be maintained in order to have a mold of the proper dimensions, to get an inlay that will fit accurately, have not mentioned the difference in the type of the centifugal and the air pressure machines. They have, in some cases, constructed an inlay oven to sell, or have advocated the use of one that will maintain certain temperatures during the drying of the mold and the elimination of the wax, and then have turned the blowpipe on the end of the mold and heated it to redness in melting the gold. This inconsistency which has been observed may be of some value to us as we proceed in the work that we have been doing on flexure tests. It is possible that we may have to heat the mold to a dull redness, adopt the use of a large sprue to allow free egress of the gold from the crucible to the mold and employ the centrifugal type of casting machines for clasps and other appliances which are to be subjected to flexure, if we get a uniformity in structure which will give a similar uniformity in behavior, and castings thin enough to make good saddles and partial dentures. It is also possible that the use of a cool mold and a smaller sprue and a quick application of air pressure may yield an inlay in the hands of the average person which, when finished, cannot be distinguished from one made by any other method.

If this discussion serves no other purpose than to get some of you to adopt *both* methods for the accomplishment of two different things, I shall be satisfied, for it will be a step toward the practice of the future. Attempts at standardization have narrowed the vision of many clinicians who are going about the country, and, as a result, they often make statements which are not only unrelated, misleading and confusing to the practitioner, but actually hinder the development of differential diagnoses and different technics which will bring into prominence things needed to render our best service.

The practice of dentistry should be based upon a good foundation of both biologic and metallurgic sciences, and each case in practice should be treated in accordance with the requirements of the case. Standardization has little or no place in professional practice. It is positively deadening to the thinking process, and should be relegated to the factories, where it belongs.

The casting of clasps, partial dentures, etc., is an outgrowth of the process of casting inlays that was presented by Dr. Taggart, and it perhaps should not be considered so very strange that what applied to the casting of an inlay has been applied to the casting of restora-

tions and appliances which are to be flexed in their use. Probably the most essential thing that an inlay should do is to fit at the margins. At least, practically all writers and clinicians seem to agree on this phase of the work. Little or no discussion has taken place about the necessity for the fit of an inlay at other points than the margins. Castings which seemed to fit equally well at other points have been regarded as defective for inlays, if they did not fit well at the margins. This is probably as it should be, for a filling of any kind which is defective at the margins has not generally been successful in the fulfilment of the requirements for a filling.

This requirement of having a casting fit well at the margins has led to the presentation of numerous reasons for some castings not doing it, and the development of some unreliable technics. For example, at the Midwinter Clinic of the Chicago Dental Society last winter, five discussions took place under the following headings: "A Standardized Method of Making Cast Restorations Which May Be Constantly Duplicated," by George M. Hollenback; "High Heat Method of Elimination," by Albert P. Grunn; "Low Heat Elimination," by R. H. Volland; "A Standardized Technic for Controlling the Variables in the Casting Process," by Herman A. Maves, and "Rapid Elimination," by H. J. Altfillisch. Four of these discussions are reported in the August number of the JOURNAL OF THE AMERICAN DENTAL ASSOCIATION, and the fifth is in the October number.

In the discussion by Dr. Hollenback, it is stated that "The purpose of this paper is to present a technic wherein the problem has not been attacked from a single angle, or to coincide with some peculiar hobby of the writer," etc. In another place in the same discussion, the following appears: "Immediately after Taggart's announcement in 1907, many attempted to share his popularity by means of various innovations and so-called improvements and short-cuts. Most of these had absolutely no merit and have long since been forgotten; others are in use today. One peculiar circumstance which is common to almost all these so-called improvements and innovations is that some single step has been heralded as a cure-all or missing link." This is an excellent premise upon which to proceed to present a standardized technic; but throughout the discussion which follows, there may be found some interesting statements which seem to indicate that the author had forgotten his premise. For example, the author states that "all cavity walls should be parallel or slightly divergent in the direction of withdrawal," etc., apparently ignoring the fact that others, who are probably just as good clinicians, advocate cavities with a considerable amount of inclination in order to facilitate the fitting of the inlay. In another place in the discussion, the author states that "the use of an air pressure machine is advocated, as neither the centrifugal nor the suction type will approach it for accuracy of results," apparently ignoring the fact that some of the profession's finest clinicians are using the centrifugal type of machine, and the further fact that many of the laboratories of the country have found that the larger sprue, which may be used with the centrifugal machine, facilitates the movement of the larger masses of gold into the mold. Further, in the discussion, the author states that "the space necessary for the cement is easily and definitely made by means of the etching process." For this etching process, nitrohydrochloric acid

is advocated. Another interesting statement appears in the discussion of the advantages of the etching process, as follows: "This method (referring to the etching process) provides a means for largely overcoming the effect of the small amount of shrinkage which exists in all castings," etc. From the latter statement, it would not appear that the author of this discussion regarded the shrinkage of gold during the cooling from the melting point as a very serious problem, and advocates an etching of the inlay to compensate for the shrinkage of the gold in order to enable the inlay to fit at the margins, as it is later mentioned.

In the discussion by Dr. Grunn, it is stated that "Men in a position to know claim that but 15 per cent of the dentists of this country are doing good inlay work," and later he claims that "The failure of inlays to fit in 90 per cent of castings can be traced directly to faulty cavity preparation." Further, in his discussion, Dr. Grunn states: "The releasing of internal stresses in a wax pattern after its removal from the cavity, unless confined in a matrix until chilled, in many instances is the cause of distorted castings. I am convinced that my success in obtaining a marginal fit is due to the fact that my wax was confined under pressure in a matrix until chilled." In another place, it is stated that "The wax pattern is now removed and examined to make sure of a slight overlap at the gingival margin, where so many think the shrinkage takes place."

It may be interesting to note, at this point, that Dr. Hollenback cares for the shrinkage of the gold by the etching process and that Dr. Grunn overlaps the wax on the gingival margin, where, as he says, "so many think the shrinkage takes place." Nowhere in the discussion by Dr. Grunn does it appear that he considers the shrinkage of the gold as a perplexing problem in obtaining a good marginal fit. With a good cavity and a slightly overlapping margin, he is apparently able to get an excellent result.

The discussion by Dr. Volland does not give much of an idea as to what he regards most important; nor does it indicate that he regards any one thing as more important than another. In fact, there is one paragraph in his discussion which seems to indicate that he realizes that there are many fine inlay workers who do not know why they are fine, and that, until they do, it would be less confusing if they confined their discussions more to the construction of the fine inlay and less to the reasons that it is fine. This paragraph is as follows: "The market provides an array of gold alloys of varying composition. Theoretically at least, each alloy has physical properties that make it desirable for certain purposes. I will not attempt to discuss the subject further except to say that satisfactory castings can be made with any of these alloys. It is the dentist's duty to select the one that is suitable for the purpose at hand." This is indeed a most wholesome statement in view of the confusion which exists as a result of some of the stunt clinics on the one piece casting, the expanded wax pattern, Dr. Jones' or Dr. Smith's gold for three-quarter crowns, and some of the amalgams which are advertised to be as strong as structural steel.

The first paragraph of the discussion by Dr. Altfillisch contains the following: "Two important steps in making successful inlays are good cavity preparation and a wax pattern." Later it is stated that "If these two preliminary steps are followed out with efficiency and skill, and a standardized tech-

nic of wax elimination and casting is added, the production of good inlays will be increased." It may be observed that he advocates the use of a large sprue and a centrifugal type of casting machine, the kind which Dr. Hollenback says will not approach the air pressure machine for accuracy of results. A large portion of the discussion by Dr. Altfillisch is devoted to investing the wax pattern, and if there can be emphasis on any one thing more than another, it would seem to be on this feature. There is no particular mention of the shrinkage of the gold nor of methods of controlling it. Four out of these five persons who gave discussions at the Chicago meeting have not given any special attention to the shrinkage and expansion of waxes and gold. The fifth one, Dr. Maves, has made, apparently as a prelude, a few confusing statements about all of us "meeting progress reluctantly," about Dr. Myers dedicating his life to service for the upbuilding of the casting process," about "our having a conviction of our destiny," about what President Coolidge is credited with saying, that "it is easy to promise everything and difficult to deliver anything," and about the casting process being in a transitory state soon to undergo far reaching modification. He then states that "wax expands on heating and contracts on cooling," that "plaster of Paris, according to Dr. Harder, expands on heating and contracts on cooling," and "alloys of gold shrink as they pass from the molten to the solid state." He could have as well stated what about every high school pupil who has had an elementary course in physics knows, viz., that about everything expands when heated and contracts when cooled.

These simple phenomena seem to have been observed with such suddenness that Dr. Maves apparently considers them the cause of some of the poor dentistry that he may have seen. Referring to these simple phenomena, he states that "all the foregoing facts have been disregarded by the majority in the casting process for the last twenty years," and he then gives what he thinks the result is. In order to improve the horrible condition to which he has referred, he gives what he designates as "certain fundamental principles," eighteen in number, of which twelve refer in some way to the shrinkage or expansion of gold. The question naturally arises: Is there a difference between what these four persons regard as good work and what Dr. Maves regards as good work? Are the four discussing methods of technic which result in the kind of work to which Dr. Maves refers as poor, or are these other four clinicians getting the same result as Dr. Maves does, by etching the inlay with nitrohydrochloric acid, by overlapping the wax at the margins, by the use of a different shaped cavity, by a careful choice of materials or by all of these processes?

Judging from the number of errors in the so-called "fundamental principles" stated by Dr. Maves, it is easier to believe that some, if not all, of the othe four persons are just as good workmen as Dr. Maves is, but they are getting the same result by emphasis on some, or all, of the other parts of the technic of casting.

It might also be stated that students have been known to get grades on fillings in both the inlay and the foil clinics by the use of home-made appliances, when the checking of cavities was a little lax, on account of the inability to detect the difference between the two with the unaided eye.

The possibility of expanding the wax pattern in order to have an inlay more accurately fit a cavity was suggested by Van Horn in 1910, and this was also suggested by Price in 1911. Dr. Price also suggested the use of small tungsten wire in the wax in order that gold would not shrink so much. He pointed out that wax which was put under a tension during the formation of a pattern, would not expand in a uniform manner when heated. Since that time, the latter phenomenon has been observed by most of our clinicians and writers. Coleman referred to it in his work at the Bureau of Standards, Grunn referred to it in his discussion; Hollenback referred to it in his discussion, and Volland referred to it in his discussion at Chicago. The latter two made some interesting comment. Hollenback stated, in his discussion, that "One operator, about ten or twelve years ago, evolved a long-drawn-out exacting method of repeated annealing of, and addition to, the wax during construction, heralding it as an absolute necessity, the use of which would solve the problem. Another advocated the use of an electrical device for carbonizing the wax and drying the mold, making similar claims, but losing sight of the fact that this is only one of the problems." Volland, while discussing the subject of the contraction of gold, stated "Many operators are using various technical procedures in attempts to compensate for this stage of shrinkage; but, up to the present time, the methods advocated are empiric and the results are not constant, in my hands at least."

Karl Elander of Gothenburg, Sweden, has presented an interesting discussion on the expansion of the wax pattern in the September *Dental Cosmos* in which he questions the accuracy of Price's deductions, and among other things points out that melted wax shows a disturbance of equilibrium while cooling. It has generally been understood that uneven expansions of heated wax were due to stresses placed on it while it was being worked, but Elander says it also occurs during the cooling of wax. He says, too, that "From this it follows that the difficulty of producing a correct wax pattern with internal equilibrium is greater than Price imagined." Further, he states that "Annealing must be carried out at at least as high temperature as that afterward necessary for expanding the pattern." He also points out that wax cannot be annealed in the tooth but must be free to expand in all directions and heated on all sides. This seems to make the expanded wax pattern applicable only to the indirect method of constructing inlays, if there is to be no distortion, and it makes the statement of Dr. Maves that "Elastic tension is largely removed by softening the wax with a hot instrument some place between points that tend to bind" appear more in error than some of his other statements included in his eighteen so-called fundamental conclusions.

The contention of Elander that wax has tension caused by working and also by cooling, and the advocacy of an annealing of it with a temperature equal to that to be used in expanding the pattern, seems to be more nearly in accord with what we know about the behavior of other materials than anything yet presented on this subject. Indeed, it may result in the removal of the technic of expanding the wax pattern from the realm of empiricism. Since Van Horn and Price observed the expansion and contraction of wax, several have rediscovered it, and like the sliced cavity preparation that has also been rediscov-

ered by two or three contenders for fame, it has been advanced as an important phenomenon to be used to compensate for the shrinkage of gold during its cooling. Some of those who, like Maves, have been most emphatic about the necessity for the use of the expansion of wax to compensate for the contraction of gold seem to have known the least about it. At least, there is little in Dr. Maves' statement that "elastic tension is largely removed by softening the wax with a hot instrument, etc.," which indicates that he knows much more about the subject than to recognize that tension in some degree exists.

Should the technic of expansion of wax be removed from the realm of empiricism and placed among the reliable methods of practice, there will still remain the task of determining the relative amounts of expansion and contraction of wax and gold, neither of which have yet been ascertained.

There will probably always be those who are able to give a good grade of service without expanding the wax pattern for anything, by giving attention to some or all of the details which have been discussed. It would seem desirable to expand the wax as Elander has suggested, though not so much as he has suggested, in the construction of the all-metal shoulder crown, and the mesioclusodistal inlay for a molar which is long from occlusal to cervical. In the mesioclusodistal cases which are short from occlusal to cervical and in those which involve only mesial and occlusal or distal and occlusal surfaces, it would seem, in most cases, unnecessary. It can be demonstrated with a trick cavity like that Price presented, or with one like that presented by the Bureau of Standards, that, with the expanded wax pattern, one can more easily make a well-fitting inlay for such cavities, than to try to do it without expanding the wax. Neither of these cavities resemble closely the cavities found in practice and should be considered as tricks or stunts. Neither of these cavities have a taper which is discernible to the naked eye, and when this is the condition, it is as logical to introduce other tricks and stunts, one or two of which I should enjoy presenting, as to associate the Price cavity or the Bureau of Standards cavity with the making of a practical inlay in the mouth, or on a model.

The effect of these tricks or stunts has been to cause many good, but very conscientious, practitioners to lose faith in their own ability and has caused them to purchase equipment which has been offered for sale and adopt new methods, not because their results were unsatisfactory, but because the stunt confused them.

If the expanded wax pattern is to be used for certain kinds of work, or for all of them, it should be considered an adjunct to the fitting and the finishing processes. An expanded wax will not make it unnecessary to fit and finish inlays or jacket gold crowns. They will always have to be fitted and finished, and it is in this particular part of the work that fine technic and ingenuity manifests itself most prominently. It is here that we can tell a good dentist better than by observing one who is expanding wax.

There is another feature of the technic suggested by Elander which has apparently been quite generally overlooked, and which seems to be quite essential, if wax is to be expanded. It is the temperature of the wax at the time that the expansion is to begin. Elander says that, after the wax pattern has been annealed by immersing it in water which has the same temperature at which the expand-

ing is to take place, it should be allowed to cool to the temperature of the room. It should then be replaced on the model and the edges corrected. Some of those who have advocated the expansion of wax have left the impression that one could start expanding from almost any point and get the same results. As a result, some who have tried the expanded wax method have, on account of the difficulty of removal of wax from some of their parallel walled cavities, used cold water from the tap, which may range in temperature anywhere from 40 to 100 F., depending on whether the water is at the temperature at which it leaves the ground, or whether it has been warmed by proximity to heating pipes, etc. Elander's suggestion, therefore, that the annealed wax be allowed to cool to room temperature and then the margins be corrected *at* this temperature is worthy of consideration.

While the suggestion of Elander that the wax be annealed at the same temperature as that at which the expanding is to take place is one which seems to be deserving of consideration, there is a possibility that his suggestion is not quite so practicable as it might at first seem to be in the construction of certain kinds of castings. He has suggested that the annealing be done at the temperature that is to be used to expand the wax, but, in practice, it sometimes happens that the wax, while in the water for purposes of annealing, will be so expanded that when it is returned to the model to have the edges corrected, it is so much out of shape that the edges cannot be corrected. In some of these cases, it is necessary to make a new wax, or add more wax, which is not an easy thing to do.

This suggests strongly that Elander's technic be followed where an expanded wax seems to be desirable, but that the temperature be kept considerably below that at which the wax is to be expanded, and for a longer time. This suggestion is offered on the basis of what we know about many other things, and especially about other metals and alloys with which we have to work. Many of these metals and alloys will anneal at either a low or a high temperature, this depending on whether the heat is applied for a long or a short time. For example, it has been shown that gold which has been hardened by being rolled into sheets can be annealed at 150 C., if the heat is applied for not less than thirty minutes; while dentists ordinarily bring the gold to a dull red color to anneal it. Moreover, it has been shown that alloys for amalgams which have been hardened by the cutting process may be annealed at room temperature, if left at that temperature for several weeks. Many other illustrations might be given which would seem to make it possible that wax also would anneal at a lower temperature if held at it for a longer time. If this should prove true and practicable in practice, it may, as has been stated, result in the removal of the expanded wax technic from the field of empiricism. It should be remembered, however, that every step away from the original cavity or abutment is likely to introduce errors greater than the ones we hope to correct, and to make it more difficult to trace the cause of errors, which occasionally creep into any technic. What appear to be improvements in the wax expanding technic are suggested as aids for those who do not succeed in certain kinds f their work by other means or who have better success by this one, and not as a panacea for all the ills of the casting process. There will always be fine clinicians who, with nicely tapered cavities, especially the axial walls, and flush wax margins,

will produce fine results. Such clinicians should use the wax expanding method sparingly until they have satisfied themselves that it is an improvement over what they are now using.

There is one encouraging feature about the casting process which is represented by the general acceptance of the present investing materials. In 1908, I suggested a method of constructing these materials in order to obtain a minimum of volume change. Since that time, the method has been refined and put into practice, and now it is possible to purchase these materials and expect a few of them to behave quite uniformly. It seems necessary, however, to guard against certain temperatures during the drying and burning-out process. For example, Coleman, who was at the Bureau of Standards, suggests that there are three expansion ranges in the heating of an investing material, and at least two shrinkage ranges. He also points out that all of these materials shrink if they are allowed to cool after being heated to temperatures above 125 C. This seems to suggest that the mold be removed and the casting made before there is time for cooling, if the greatest accuracy is desired.

It has been quite customary to cast into a cool mold. In fact, when I was in charge of the inlay clinics, I did it, too, because it seemed to be easier to get sharp margins by this method. We argued that the gold should congeal immediately when it reached the margin portions of the mold, and there is still something to be said about allowing the gold to remain in a fluid condition in the mold unless the pressure is well maintained. The investing materials which are now being used are stronger than we then used, and an increase in the pressure has been made without a noticeable amount of distortion of the mold. This seems to make it possible to cast at the temperature at which the wax has been eliminated without much, if any, sacrifice of sharpness of the margins. However, it is doubtful that casting at the temperature at which the wax has been eliminated will uniformly result in sharper margins than casting in a cool mold.

This brings to our attention another of these misleading and confusing conditions in practice which are used by some clinicians to make it appear that they have discovered something very important. The fact that some clinicians make certain types of inlays with the cool mold and get good results seems to justify the use of this method, if those types of inlays are the only kind they make. It oftentimes is discovered that dentists do the things most which they do the best. In such cases, if a dentist made but few or none of the jacket gold crowns, or long mesioclusodistal inlays in molars, he might be quite enthusiastic about casting into a cool mold. On the other hand, if all kinds of work were being done, an equal amount of enthusiasm might be found in regard to casting into a mold as hot as was used to remove the wax.

This recalls a statement once made by that genius in this work, C. S. Van Horn, that "sharpness in wax patterns does not necessarily imply dimensional precision," for this statement applies so aptly here. Sharpness of margins does not necessarily mean that the remainder of the inlay is dimensionally correct. If a long mesioclusodistal inlay in a molar has shortened in a mesiodistal direction, or if a gold jacket crown has had its diameter lessened more than normal, sharp margins are not likely to let it go to place. Of course, they would assist

materially in getting a good result, but it would be the margins rather than dimensional accuracy that had saved the operation from failure. On account of the shrinkage of the investing material, if allowed to cool down, a casting made at the temperature at which the wax was removed should be a little nearer dimensionally correct. In addition to expanding the wax, it would, therefore, seem desirable to cast into a mold at a temperature at which the wax was removed or a higher temperature whenever one of the trick fillings, long mesioclusodistal molar inlays or gold jacket crowns, are to be made.

A little has been said and written about the amount that wax expands and contracts, and the amount that gold expands and contracts when these two materials are heated and cooled, but there is practically nothing authentic on this subject available. Price estimated the shrinkage of gold at from 1.60 to over 2.00, and Coleman has done the same with one or two alloys and given it as approximately 1.25. In regard to the waxes, little that is authentic is available. Coleman stated that there had been observed a difference in the rate of expansion with some of the waxes with different temperatures. He stated, also, that the work on the subject was being continued. All that can be said at the present time about expanding a wax a given amount and expecting this expansion to compensate for the shrinkage must be based upon trial and experiment until a technic is found which helps most, in that most important of all phases of inlay work, viz., the fitting of the inlay and the finishing of the margins.

There are several other aspects of our metallurgic work which it would be well to discuss, but it hardly seems practicable to do so at this time. It is somewhat difficult for me, in view of the amount that I have written on the subject of amalgam, to refrain from discussing the statement of the L. D. Caulk Company in the October number of the *Milford News* that "Twentieth Century Alloy" is "one that becomes as strong as structural steel in the patient's tooth," but this will have to be deferred until another time.

It would appear more advisable to conclude with a summary of some of the important conclusions which have been drawn from this review of the literature and some work in our laboratory. The conclusions follow:

1. Alloys that are cast into clasps or any other appliances which are required to bend may not be the most desirable ones to use for any other purpose.

2. Until an alloy has been found which can be demonstrated to resist the greatest number of bends and also possesses the other properties necessary to make a large one-piece partial denture, it seems better to make the main part of the denture and the clasps of different alloys.

3. Alloys that are made in clasps will undoubtedly need heat treament after the metal part of a restoration has been completed, and the profession should scrutinize the literature of the future for the results of investigations now in progress.

4. Alloys of gold have already been demonstrated to be subject to heat treatment and capable of forming different compounds between the congealing point and room temperature. This seems to confirm the belief that appliances which are required to bend will have to be heat treated, if the best results are to be obtained. Heat treatment may never be required for other castings which do not bend.

5. The frequency with which oxids and other foreign matter appear in the broken specimens exhibited indicates clearly that greater precautions to prevent oxidation are necessary in constructing an appliance which has to be flexed than may be necessary for other work.

6. Alloys of four metals have uniformly given greater resistance to flexure tests than those which contain six or seven. The alloys which have had the platinum substituted by nickel and zinc have not shown such great resistance to flexure tests as have those which contained platinum.

7. In all cases, alloys which have shown high resistance to flexure tests have had a fine grained structure.

8. The contraction of the different golds when cooling from the temperature used in casting to that of the room has not been determined. On the basis of a few experiments which have been made and what we know about the shrinkage of other alloys and metals, it is probably more than 1 per cent and may be as much as 1.75 per cent, in some cases.

9. The centrifugal type of casting machine, when used with a large sprue, appears to have some advantages over the air pressure machines, as they are now constructed, for large castings and perhaps for the casting of clasps and other appliances which are to be subjected to flexure.

10. Both the centrifugal and the air pressure machines will cast good inlays.

11. Waxes seem to have their internal equilibrium disturbed both by working them and by cooling from a molten condition to a solid one.

12. The annealing process suggested by Elander seems to be the best known one to use when wax is to be expanded to compensate partially for the shrinkage of the gold, although the annealing temperature suggested by him seems too high for practical purposes.

13. The hot mold seems to be desirable whenever a large thin casting is to be made. If, during the rise in temperature up to dull redness, the model on which the casting is being made changes in form and volume, the casting should be swaged to a stone model.

14. The mold, into which the casting has been made at the temperature at which the wax is removed, will probably yield best results whenever the jacket gold crown, large, long mesioclusodistal molar inlay or some of the trick inlays are to be made.

15. The cool or cold mold will yield good results for other castings, if skill is used in the fitting, although this method of practice does not seem to be most desirable.

16. It is not known whether the use of the hot or of the cold mold is more desirable when clasps and other appliances which have to be flexed are to be constructed.

17. A heat treatment of the completed metal part of the restoration seems certain to become a part of good practice.

18. Cavities and abutments for jacket crowns with a plainly visible taper facilitate the removal of the pattern, the stretching of the gold and the fitting of the casting. Parallel walled cavities and abutments are seldom, if ever, necessary to retain these castings, if one of the most adhesive cements is used for retention.

STUDIES OF GERMICIDES FOR THE TREATMENT OF ROOT CANALS*

By EDGAR D. COOLIDGE, B. S., D. D. S., Chicago, Ill.

A STUDY of antiseptics for the purpose of sterilizing carious dentin was reported by W. D. Miller[1] in 1891. One of his principal conclusions was that it requires much more time than we are accustomed to give to sterilize carious dentin. The antiseptic should be sealed in the cavity and protected from the saliva for at least one-half hour. His observation also led him to the conclusion that substances readily soluble in water have the most rapid action. The strength of antiseptics, principally essential oils, was reported in a very comprehensive manner two years earlier, in 1889, by G. V. Black.[2] For his tests, the organisms used were those taken from the saliva. His report shows that some of the essential oils, such as oil of cassia, cinnamon, mustard and cloves, have a high range of antiseptic power, while others have none at all.

The test of the strength of a few of the drugs used at the present time for pulp treatment and for the sterilization of infected root canals was begun by us because of a desire to observe the action of these drugs on a mixed culture of organisms taken from a root canal of a tooth where an acute or chronic apical alveolar abscess or granuloma was in evidence. The culture was taken after the rubber dam was placed and the surfaces of the exposed teeth were carefully cleaned with alcohol, after which they were painted with tincture of iodin. The tooth was carefully opened and the pulp chamber exposed, and the culture was taken from the apical portion of the canal. The mediums used for all cultures was the glucose-hormone brain broth[3] used in the Research Laboratory at Northwestern University Dental School, similar to that recommended by E. C. Rosenow[4] for culturing streptococci.

The tests of this report were made along the lines suggested in the Rideal-Walker tests and in Hygienic Laboratory Bulletin No. 82 of the Bureau of Standards, Washington, D. C., April, 1912, so that a comparison might be made between these drugs, with phenol as a standard. The standard tests by which the phenol coefficient of drugs is determined are made by finding the dilution of a given drug that will kill *Bacillus typhosus* in a specified time, as compared to the dilution of phenol that will also kill the organism in that time. (Table 1.)

*From the Research Laboratory of the Northwestern University Dental School.

1. Miller, W. D.: Comparative Rapidity with Which Different Antiseptics Penetrate Decalcified Dentin, or What Antiseptics Should Be Used for Sterilizing Cavities Before Filling, Dent. Cosmos, 33:337 (May) 1891.

2. Black, G. V.: Antiseptics, Dent. Rev., 3:128 (Feb. 15) 1889.

3. Bailey, Sadie F.: Hormone Mediums, J. Infect. Dis., 36:340 (March) 1925.

4. Rosenow, E. C.: Studies on Elective Localization, J. Dent. Res., 1919, p. 205.

The phenol coefficient refers to the comparative strength of a drug against the organism with which the tests were made, and the value of the drug against other organisms is established only by tests made on them. The Committee on Standard Methods of Examining Disinfectants of the Laboratory Section of the American Public Health Association, at the annual meeting in 1917, recommended "the determination of the phenol coefficient against disease producing types of bacteria other than *Bacillus typhosus,* particularly the ones against which the disinfectant is to be used."[5] The organisms found in a gangrenous and putrefying pulp or in an abscessed tooth are not always the same, but the streptococci and staphylococci predominate, while many varieties of bacilli and rods can be seen, only a few of which have as yet been identified as pathogenic. Many authors have reported such findings, among which are Rosenow, Mayerhofer, Gilmer, Davis and Moorehead, Rickert and others. If phenol in a 1:100 dilution will destroy *Bacillus typhosus* in ten minutes at 20 C., it would be of interest to know what dilution would be required to destroy a mixed culture taken from an abscessed tooth. The literature contains many reports of tests in which *Bacillus typhosus* and *Bacillus coli* have been used, but, so far, I have found no references to a culture being taken from an abscessed tooth for such tests of germicidal strength.

TABLE 1.—METHOD OF DETERMINING THE PHENOL COEFFICIENT OF A GERMICIDE*

Sample	Dilution	Time of Exposure to Action of Disinfectant in Minutes						Phenol Coefficient
		2.5	5	7.5	10	12.5	15	
Phenol	1:80	−	−	−	−	−	−	
	1:90	+	−	−	−	−	−	
	1:100	+	+	+	−	−	−	
Disinfectant A	1:375	−	−	−	−	−	−	
	1:400	+	−	−	−	−	−	
	1:450	+	+	−	−	−	−	550
	1:550	+	+	+	−	−	−	———
	1:600	+	+	+	+	−	−	100=5.5

*The dilution of the unknown that will destroy an organism in a given time divided by the dilution of phenol that will destroy it in the same time gives the coefficient of the unknown.

*Name of disinfectant, A; temperature of medication, 20 C.; culture used, B. typhosus, twenty-four-hour extract broth filtered; proportion of culture and disinfectant, 0.1 c.c. culture to 5 c.c. drugs.

A report by G. F. Reddish[6] in 1927 shows the results of tests made on staphylococci at a temperature of 20 C. The dilution of phenol required to destroy the organisms varied with different strains, but 1:60 always destroyed them in ten

5. Reddish, G. F.: Examination of Disinfectants, Am. J. Pub. Health, 17:326 (April) 1927.

6. Footnote 5, p. 320.

minutes, while 1:70 destroyed some strains in ten minutes. Hemolytic streptococci were killed by a 1:90 dilution in ten minutes, and pneumococci were killed by a 1:100 dilution in ten minutes.

TECHNIC

All of my tests were made in exactly the same way and under the same conditions. Organic matter was used in all tests, as pulp treatment must be carried out in the presence of more or less organic matter, which reduces the effect of germicides. For this purpose, a similar amount of peptone and gelatin was used as that employed in the tests made by Feirer and Leonard[7] with hexylresorcinol solution S. T. 37. In each test tube, 0.2 gm. of peptone and 0.1 gm. of gelatin was thoroughly shaken with 10 c.c. of the undiluted drug to be tested. This was tested or diluted with distilled water to the desired strength for the test. All tests were made in the proportion of 5 c.c. of solution inoculated with two standard loopfuls of a forty-eight-hour subculture taken from an original culture from the root canal of an abscessed tooth and transferred several times at forty-eight-hour intervals before being used. The inoculated drug was then placed in a water bath and kept at 37 C. during the test. At intervals of two and one-half minutes, as indicated in Table 2, a tube of culture mediums was inoculated and marked. After all inoculations were made, the tubes were incubated at 37 C. for five days and then examined by smear under the microscope.

Phenol always killed the organisms in the dilution of 1:80 in ten minutes. In four tests out of ten, the organisms were killed in 1:100 strength in ten minutes. Hexylresorcinol solution S. T. 37 killed the organisms in a dilution of 1:5 in ten minutes by this test, which gives the solution a coefficient of 0.0625. It being a solution of 1:1,000 to start with, this would represent a dilution of 1:5,000 and the coefficient for the solution would be 62.5. Trichlor killed the organisms in a dilution of 1:40 in ten minutes, giving it a coefficient of 0.5. The solution being 2 per cent to start with, this would represent a dilution of 1:2,000 in the test and the coefficient would be 25. The solubility of cresatin in water at body temperature was found to be so low that the dilution was not germicidal in the time limit of this test. Many solvents were tried, the best of which were acetone and benzene. Equal parts of ace-

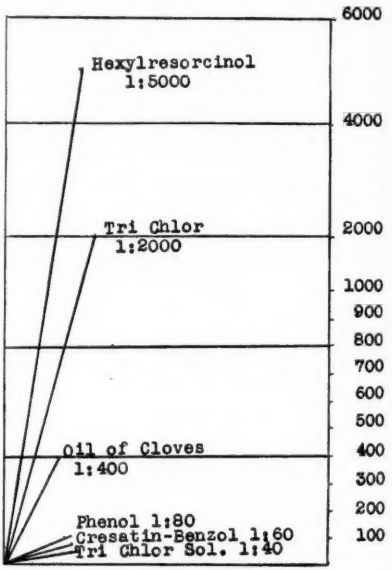


Fig. 1.—Dilutions which destroy the organisms from an infected root canal in ten minutes.

7. Feirer, W. A., and Leonard, Veader: Hexylresorcinol in Oral Antisepsis with Special Reference to Solution S. T. 37, Dent. Cosmos, 68:882 (Sept.) 1927.

tone and cresatin could be diluted with water up to 1:10 and the solution was still germicidal in ten minutes. Cresatin killed the organisms in a dilution of 1:60 in ten minutes when one part of benzene and 58 parts of distilled water was used, giving it a coefficient of 0.75. Oil of cloves in 1:400 killed the organisms in ten minutes, showing a coefficient of 5.0. The same phenomena occurred with the power of oil of cloves as a germicide when one part of benzene was added as it seems to raise their germicidal power greatly. (Fig. 1 and Table 2.)

In an attempt to interpret these figures into terms of clinical application, it might seem that, because of the range of power of hexylresorcinol solution S. T. 37, it should greatly excel trichlor and cresatin for root canal treatment, since their strength is only about half that of phenol, while oil of cloves, with a coefficient of 5, would be about ten times as efficient as trichlor or cresatin. There

TABLE 2.—TESTS OF GERMICIDES FOR DILUTION THAT WILL DESTROY ORGANISMS FROM AN INFECTED ROOT CANAL IN TEN MINUTES*

Name of Germicide	Dilution	Control	Time of Exposure in Minutes							Phenol Coefficient
			1	2.5	5	7.5	10	12.5	15	
Phenol	1:60	+	+	+	−	−	−	−	−	
Phenol	1:80	+	+	+	+	+	−	−	−	
Phenol	1:100	+	+	+	+	+	+	+	−	
Hexylresorcinol S. T. 37	1:4	+	+	+	+	−	−	−	−	
Hexylresorcinol S. T. 37	1:5	+	+	+	+	+	−	−	−	0.0625†
Hexylresorcinol S. T. 37	1:6	+	+	+	+	+	+	−	−	
Trichlor	1:20	+	+	+	+	−	−	−	−	
Trichlor	1:40	+	+	+	+	+	−	−	−	0.5000‡
Trichlor	1:50	+	+	+	+	+	+	−	−	
Cresatin	Benzene 1, H_2O-28	+	+	+	+	−	−	−	−	
Cresatin	Benzene 1, H_2O-48	+	+	+	+	−	−	−	−	0.7500
Cresatin	Benzene 1, H_2O-58	+	+	+	+	+	−	−	−	
Oil of cloves	1:300	+	+	+	−	−	−	−	−	
Oil of cloves	1:400	+	+	+	+	+	−	−	−	5.0000
Oil of cloves	1:500	+	+	+	+	+	+	+	−	

*Temperature, 37 C.; culture used, mixed culture from infected root canal in hormone brain broth; time, forty-eight hours; proportion of culture and germicide, two standard loopfuls to 5 c.c. of diluted drug.

†Hexylresorcinol solution S. T. 37 is a 1:1,000 solution of hexylresorcinol. The dilution above is really 1:4,000, 1:5,000, 1:6,000 and the computed phenol coefficient is 62.5 by this test.

‡Trichlor here is a 2 per cent solution of full strength trichlor. The dilution above is really a 1:1,000, 1:2,000, 1:2,500 and the computed phenol coefficient is 25.

was noticed when it was added to cresatin. The dilution of oil of cloves 1:800, of which one part was benzene, killed the organisms in ten minutes. Benzene alone has little germicidal power except in full strength. When added in very small amounts to cresatin or oil of cloves, are other factors to be considered which have some relation to the clinical application of these drugs in treating root canals.

CLINICAL APPLICATION

Two separate and distinct conditions must be recognized in the consideration

of root canal treatment: (1) the canal that contains living pulp tissue and (2) the canal that contains a gangrenous and infected material. Different stages of inflammation may co-exist in vital pulp tissue from a necrosis on the surface to a fibrous condition in the apical region. This tissue may be infected on the surface and yet react to pain stimuli beneath. Such a pulp must be removed without pain to the patient and, at the same time, without carrying the surface infection into the periapical region. Attempts to remove this pulp by any method without destroying the infection in the surface layer are sure to carry the organisms into the periapical region and result in tissue changes which are later revealed by the roentgenogram as rarefied or translucent areas. In this discussion, there will be no consideration of the requirements of the removal of living pulp other than that which pertains to germicidal treatment before pulp removal. Surface disinfection is essential to the success of operations in pulp removal.

Chemico-therapeutics seeks to produce the most efficient germicide that can be safely used on living tissue; one that will destroy pathogenic bacteria in the shortest space of time without arresting the vital reactions of the tissue. Bacteria and their poisonous products cause inflammation and death of living tissue. Germicides are resisted by the tissue, and if they do not destroy the vital forces, they become changed and finally absorbed and carried away. In this process, bacteria that have been destroyed are also disposed of by the body cells. When this is accomplished, a return to normal follows.

There are three important factors of germicidal action which must be observed in all cases as suggested by Hermann Prinz:[8] "absolute contact, time during which the contact is maintained, and sufficient concentration of the employed antiseptic."

The principle of "contact" brings up the question of the penetration of germicides and the relative value of drugs in actually destroying organisms deeply seated in multi-canaliculated root canals containing gangrenous and putrescent organic material, and it is possible that some dentinal tubules might harbor organisms as well. Organisms protected by decomposed organic material must be reached by the germicide before they can be destroyed. The concentration of the drug and the time required to destroy the organisms must always be determined by laboratory tests to prove the efficiency of the treatment.

In addition to these three principles, it is equally important that the germicide be not highly irritating to the tissue. The success of root canal treatment must be judged by the picture of the periapical tissue and bone as revealed by the roentgenogram. Drugs that irritate severely are destructive and cause bone and tissue changes to appear in the periapical area[9] which are extremely difficult to differentiate from similar areas caused by toxic products of micro-organisms or by the organisms themselves. Organisms growing at the surface of an exposed pulp must be destroyed without causing pain when the germicide is sealed on the exposed but still vital pulp. This is one of the most important steps in the treatment of root canals, since the same or-

8. Prinz, Hermann: Diseases of the Soft Tissue of the Teeth and Their Treatment, Philadelphia: Lea & Febiger, 1928, p. 222.

9. Lüthi, H. R.: The Effect of Chlorphenol, Phenol, Tricresol-Formalin, Triopaste, "Albrecht's Root Filling" and Eugenol on the Periodontium of Dogs, Vierteljahrsschr. f. Zahnheilk., 44:96, 1928.

ganisms may be found in carious dentin and at the surface of the exposed pulp as are found deeper in the root canal containing a necrotic pulp. Drugs which coagulate protein have only a shallow penetration and are not qualified for the treatment of infected canals containing organic matter.

Another important consideration is the length of time during which the germicide is expected to remain active or unexhausted. Some drugs, such as the

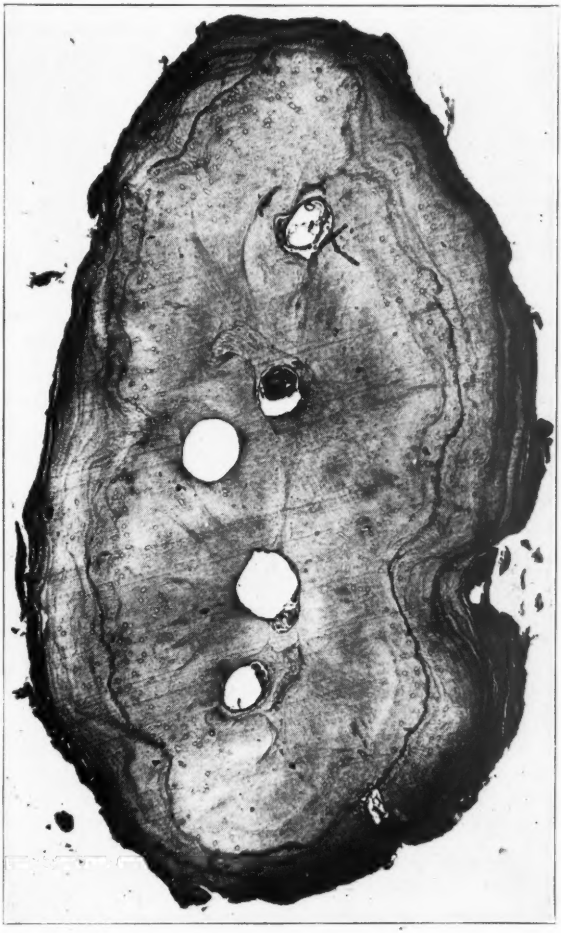


Fig. 2.—Cross-section of upper bicuspid root showing five canals. The penetration of germicides into all accessory canals is necessary to destroy the organisms present.

chlorin preparations, have a short period of effect and must be replaced at rather short intervals owing to their great solubility or chemical activity. Some drugs which are slowly soluble will remain effective longer because, as the active principle is used in destroying the organisms, it will be replaced by the further solution of the substance. This is observed in such substances as thymol and cresatin.

PENETRATION OF GERMICIDES

The penetration of germicides into the accessory canals branching off from the main canal (Fig. 2) is an important factor in preventing deep-seated infection from reaching the periodontal tissue at a later time, months or years after the root canal filling is completed. Disinfection takes place after the distribution of the drug. "This distribution may occur either in the manner of a chemical combination, adsorption or in accordance with Henry's law."[10] This law refers to the distribution of a gas between a fluid and a gaseous phase proportionately to the pressure.

Disinfection in principle is quite a similar process to the staining of micro-organisms. Quoting from Bechhold: "It follows from the ease with which they are stained that surface attraction is of great importance in the case of bacteria, and in fact staining and disinfection are distinguished only by the fact that, in the latter instance, the absorbed substance exerts a particular poisonous action on the micro-organism."

A germicide that lowers the surface tension of the medium tends to concentrate on the surface. It thus becomes more destructive to organisms because

TABLE 3.—SURFACE TENSION OF SOME DRUGS AND SOLUTION EXPRESSED IN DYNES PER CENTIMETER*

	Temp. (C.)	S. T.		Temp. (C.)	S. T.
Acetic acid (1)	20	27.6	Water	26	72.4
Acetone (1)	20	23.7	Phenol 95% (1)	30	39.9
Alcohol (ethyl) (1)	30	21.4	Phenol 1:80 (1)	20	57.0
Benzene	26	30.0	Phenol 1:100 (1)	20	61.1
Cresatin	26	37.7	Cresatin	29	37.7
Cresol (meta) (1)	20	37.4	Cresatin 1:100	29	52.3
Creosote	26	40.2	Cresatin 1:100	29	45.2
Ether (1)	20	16.8	Benzene 1:100	29	45.2
Hexylresorcinol (solution S. T. 37)	29	32.2	Cresatin 1:50	29	44.6
Oil of cloves	26	37.7	Benzene 1:50	29	44.6
Sodium oleate sat. sol.†	..	25.0	Cresatin 1:100	29	49.8
Trichlor	26	50.0	Acetone 1:100	29	49.8
Mercury (1)	15	487.0			
Ethyl acetate	20	24.3			

*The figures for all substances marked (1) were taken from the International Critical Tables, Volume IV. The temperature given for all other liquids is that of the room rather than of the substance tested.

*Du Noüy, P. L.: An Apparatus for Measuring Surface Tension, J. Gen. Physiol., 1919, p. 521. The surface tension of the drugs and solutions was tested by means of the Du Noüy Precision Tensiometer.

†Hodgman and Lang: Hand Book of Chemistry and Physics, Edition 2.

10. Bechhold, H.: Colloids in Biology and Medicine, p. 391.

more molecules are attracted to the surface of the organism by adsorption (Fig. 3), and there is more rapid diffusion through the cell membrane. "Any factor which might increase the number of molecules of the germicide in contact with an organism at a given moment or which might accelerate their diffusion through this membrane would increase its bactericidal efficiency."[11]

Surface tension as described by Bechhold, "is that force that pulls toward the center of a drop of water that it may have the smallest surface possible."[12] It can be easily measured by the force required to pull a ring or plate from the surface of a liquid or by the pull of a suspended drop of the liquid (the force equals the weight of the drop at the moment it falls). The liquid of low surface tension would drop faster and in smaller drops than one of high surface tension. The lifting force required to lift the ring from the surface of a liquid is expressed in dynes per centimeter of surface. One dyne represents 1/980 gm. of lifting force. Alcohols, phenols and soaps are among the more powerful surface tension reducing agents. Martin Frobisher, Jr.,[13] demonstrated that the germicidal power of phenol and hexylresorcinol can be further increased by the addition of a definite amount of sodium oleate or ethyl acetate, which reduces their surface tension. Thus, a germicide which was destructive to organisms in ten minutes might be made effective in five minutes by the addition of a nongermicidal substance which would reduce its surface tension. (Table 3.)

11. Footnote 7, p. 885.

12. Footnote 10, p. 16.

13. Frobisher, Martin, Jr.: Studies upon the Relationship Between Surface Tension and the Action of Disinfectants with Special Reference to Hexylresorcinol, J. Bacteriol, 13:163 (March) 1927.

Frobisher states: "Fluids of very low surface tension may, under some circumstances, permeate or penetrate into minute crevices or interstices more readily than fluids of high surface tension. The laws governing capillary rise and the limitations due to viscosity must, of course, be considered when interpreting this generalization." (p. 163.)

"Osmosis and diffusion are known to be materially accelerated under certain conditions by lowering the surface tension of fluids involved." (p. 164.)

"Disinfectants which lower surface tension are adsorbed on the surfaces of the organisms to be killed and therefo e exist in higher concentration at the most effective point." (p. 164.)

He also found that "where an excess of solid surface tension reducent (like sodium oleate) is added to disinfectant solutions, enough reducent is adsorbed on the surface of the cells to prevent contact of the disinfectant and the cell." (p. 169.)

"There is reason to believe that the surface tension reducent induces changes in the permeability of the membrane, which facilitate the entrance of the drug into this membrane." (p. 173.)

The principle of the better penetrating power of liquids of low surface tension is more easily understood when one recalls how readily oil soaks into wood and alcohol or essential oils soak into woolen cloth, while water remains on the surface in drops for quite a time. (Fig. 4.)

In the decomposition of the pulp tissue, besides nitrogenous products and gases, there is a certain amount of fat and fatty acid released or produced. An accessory canal containing any fatty matter (Figs. 5-6) would be more resistant to germicides unless they either combine with the fat or dissolve it. Aqueous solutions

would scarcely penetrate, while fat solvents might enter and allow germicidal contact with organisms thus protected. Soap, a product of fat and alkali, is useful in freeing the surface of the skin from dirt by emulsifying the fat and releasing the dirt which is incorporated in it. Fat solvent properties or substances which are readily soluble in fat and still retain their germicidal activity are essential in penetrating and disinfecting accessory canals. It is important that a liquid wet the walls of the canal before it can enter.[14] "Liquids that do not wet the walls of the capillary not only do not rise in the tube but are depressed by it. In this case there is a layer of adsorbed air between the liquid and the tube."[15] The measure of capillary rise of liquids

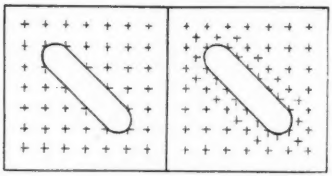


Fig. 3.—Adsorption, by bacteria, of germicides which reduce surface tension. Left, dispersion of molicules (+) in solution of a germicide which does not lower surface tension, showing equal distribution throughout the solution; right, mechanical adsorption, by bacteria, of germicides which lower surface tension. Concentration of the germicide (+) occurs at the most effective point, i. e., on the surface of the organism. The rate of diffusion of the germicide into the cell is also increased. (From Feirer and Leonard, Dent. Cosmos, 1927, p. 886.)

in a capillary tube of known bore is another method of measuring surface tension. Liquids of low surface tension are penetrating, and they must wet the walls of the canal or tubule in order to enter. (Fig. 4.)

Clinical requirements and clinical results must be considered, as well as laboratory tests; for it is often found that a drug with a very high phenol coefficient is not satisfactory in clinical practice. It is also found, in some cases, that a drug which has little effect on organisms in a test tube is very effective when injected into the tissue; for example, arsphenamin, a specific against *Spirocheta pallida* but unable to kill organisms in the test tube.[16]

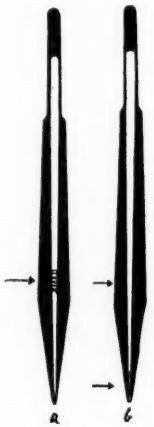


Fig. 4.—Penetration. Wetting by a liquid of low surface tension. A drop of water placed at point marked by arrow (left) will remain at the same point when the instrument is held in a vertical position. A drop of liquid of low surface tension placed at the same point in the instrument (right) will immediately run down to the point and drop off when held in a vertical position. Liquids of low surface tension should penetrate more readily into crevices and accessory canals if they do not coagulate protein (Fig. 7).

Cresatin does not have a high phenol coefficient but has a very good clinical

14. McClendon and Medes: Physical Chemistry in Biology and Medicine, p. 52.

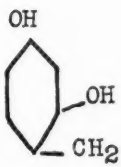
15. Alcohol is an example of a liquid that readily wets a surface. Water will not wet it so easily, and mercury, not at all.

16. Pryde, John: Recent Advance in Biochemistry, p. 322.

record. Oil of cloves shows a very good coefficient and seems more efficient clinically than is generally considered. Tests made by MaWhinney[17] in 1900 do not show the germicidal action of oil of cloves, and others have given similar reports. Prinz[18] states that essential oils are more irritating to the higher organisms than to the lower forms of life and that continuous application will cause atrophy of the pulp. G. V. Black found that oil of cloves would prevent growth in culture mediums when diluted to 1:1,200, while phenol only prevented growth in 1:300. Benzene reduces the surface tension of other germicides and will dissolve fats, thereby assisting in penetration.

It seems that staphylococci and streptococci are more resistent. As can be seen in Table 2, these tests gave it a phenol coefficient of 62.5. After the addition of the sixth group, the preparation becomes so nearly insoluble that it is of little value as a germicide. One of its most important characteristics is its power of reducing surface tension of liquids, which increases their penetrating power. The surface tension of the solution is expressed by the number 37. The surface tension of distilled water being about 72.4, it has close to one-half the surface tension of water. The samples used in this experiment tested 32.7 at room temperature. (Table 3.)

Hexylresorcinol is nontoxic and, in dilute solutions, is almost nonirritating to the tissue. It is used internally as well as externally. Solution 37 can be used in full strength in the mouth. It does not coagulate albumin and is very slightly affected by organic matter. It has many qualifications for a good remedy for root canal treatment, but clinical experience is too limited to report at this time. Solution S. T. 37 has been a most satisfactory remedy when applied in diluted strength in infections of the soft tissue of the mouth and throat, or when injected in full strength into pyorrhea pockets after scaling of the teeth. The study of its properties has been very helpful in analyzing and comparing other agents which have given very excellent clinical results in root canal treatment.



Hexylresorcinol $CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_3$.

Hexylresorcinol solution S. T. 37 is a preparation containing one part of hexylresorcinol dissolved in 300 parts of glycerin and 700 parts of water. The drug is a crystalline substance only slightly soluble in water (1:1,500), but readily soluble in organic solvents. It is a synthetic product built up by the addition of a group containing six carbon atoms to the resorcinol base or nucleus. With the addition of each methylene group, the germicidal power is increased until a phenol coefficient of over seventy times phenol is recorded for it. This coefficient was determined against *Bacillus typhosus*.

17. MaWhinney, E.: Tr. Illinois State Dent. Soc., 1900, p. 125.

18. Prinz, Hermann: Dental Materia Medica and Therapeutics, St. Louis: C. V. Mosby Company, 1926, p. 191.

TRICHLOR

Trichlor is an alkalinized solution containing sodium para toluene sulphon chloramid (chloramin T), sodium hypochlorite and sodium chlorid. In 100 per cent strength, the solution is credited with a phenol coefficient of 50 when tested against typhoid organisms under the conditions of the Rideal-Walker test. It is a reasonably stable liquid, but should be preserved in colored bottles and kept from the light. It is reported to have between 11.5 and 13 per cent of active chlorin. It combines readily with tissue secretion and dissolves albumin. It acts by oxidation and chlorination after dissolving the surface envelop of the bacteria. It will prevent growth of bacteria in dilutions of 1:125,000. It is decomposed by alcohol.

The solution available for use in dentistry and medicine known as trichlor is a 2 per cent solution. The report above (Table 2) shows this solution to have a phenol coefficient of 0.5 when tested against the mixed infection from an abscessed tooth containing streptococci, staphylococci and rods. This solution destroys the organisms in one minute. It has a surface tension of 50 (Table 3). It has a strong chemical affinity for protoplasm and other organic matter. It is a solvent of pus and necrosed tissue and neutralizes toxic products of bacteria. "According to Dakin and his collaborators, chlorine forms chloramines when it acts upon protoplasm and these chloramines have an antiseptic action."[19]

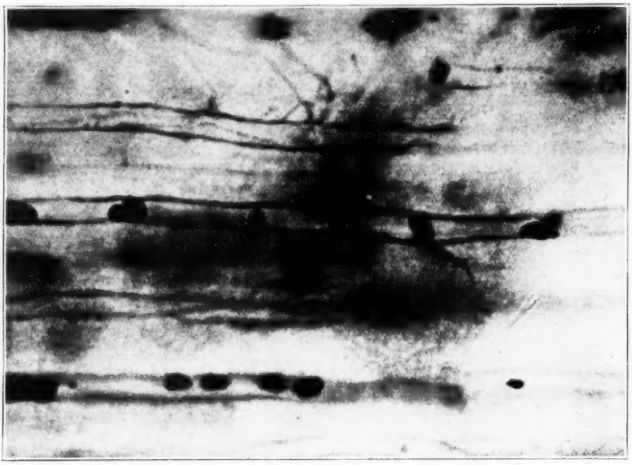


Fig. 5.—Appearance of fat droplets in the odontoblast processes. (From Euler and Meyer; Pathohistology of the Teeth, p. 105.)

The solvent action of sodium hypochlorite on albumin is a valuable property where there is dead tissue which harbors anaerobes. This permits no organisms to escape, while if coagulating drugs are used, the surface of a necrotic mass becomes hardened and impermeable to the action of the drug. In the presence

19. Footnote 10, p. 405.

of blood or secretions, chlorin action is greatly reduced as are all other agents but in less proportion. Free chlorin oxidizes many organic compounds and liberates hydrochloric acid. ($PNH_2 + Cl_2 \rightarrow PNHCl + HCl$.)

TRICHLOR IN ROOT CANAL TREATMENT

In the treatment of gangrenous and putrescent root canals or after removal of an old root canal filling, trichlor is very effective. It dissolves albuminous matter and chlorinizes poisonous protein

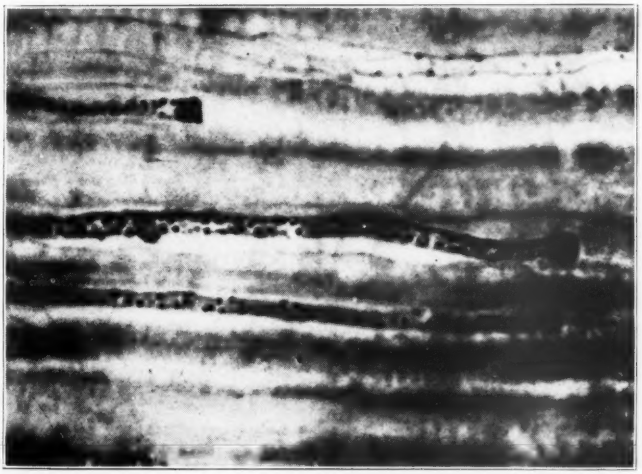


Fig. 6.—Fine fat droplets in the odontoblast processes. (From Euler and Meyer; p. 105.)

decomposition products, releasing oxygen. Chlorin gas penetrates the canals and inaccessible spaces. It neutralizes both toxic products and the gases of putrefaction. The treatment must be replaced frequently, preferably every twenty-four hours, in order to renew the supply of free chlorin. In the prescribed strength, it rarely causes irritation to the soft tissue beyond the foramen. When applied on a vital pulp, it should be diluted to prevent irritation. The pulp chamber should be flooded after the necrotic tissue has been removed from the mouth of the canal, without disturbing the contents of the mid root. After absorbing the excess, a small pledget of cotton saturated with trichlor should be carefully sealed in the pulp chamber with cement. At the second sitting, twenty-four hours later, the contents of the canal may be safely removed by the usual curettement and mechanical treatment and the canal flooded with trichlor again. The excess should be absorbed and an absorbent point carrying trichlor should be placed well up in the canal, but not far enough to come into contact with the vital tissue beyond the foramen. This should be allowed to remain twenty-four hours. At the third sitting, the treatment should be varied according to the condition. If the canal is not free from odor, another treatment should be applied; but if free from odor and exudate, the canal may be filled. The absence of odor is not a positive proof of

cleanliness of the canal, but it is an aid in determining the proper time to fill the canal. Chlorin is a lymphagogue, and often the canal will be found very moist after the treatment has remained twenty-four hours. After the third treatment, if such a condition is found a sterile absorbent point may be sealed in the canal for twenty-four hours. It is a safe precaution to seal a mild nonirritating application in the canal for a few days before filling, such as eucalyptol compound or cresatin; after which the canal may be filled. Chlorin is especially valuable in treating the canal of a tooth which has become discolored, as it is also a bleaching agent. Chlorin acts on water and releases nascent oxygen, which destroys the color molecule. ($H_2O+Cl_2 \rightarrow 2HCl+O$.)

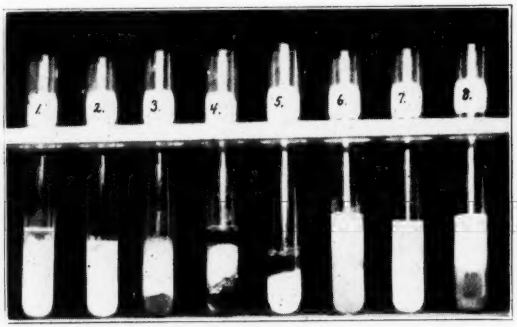


Fig. 7.—Action of various drugs on egg albumin. Note difference in reaction in the tubes *1-8* and from *9-14*, (Fig. 8). A heavy coagulum is formed in the tubes of group *1-8*. *1*, acetone; *2*, alcohol; *3*, oil of cloves; *4*, beechwood creosote; *5*, cresol; *6*, eugenol; *7*, phenol 5 per cent; *8*, sulphuric acid. Figure 8 shows *9*, bensol; *10*, cresatin; *11*, cresatin in water; *12*, eucalyptol; *13*, hexylresorcinol solution S. T. 37; *14*, trichlor. A very slight coagulum occurs in eucalyptol, and trichlor dissolves albumin. There is hardly any noticeable change in the other tubes.

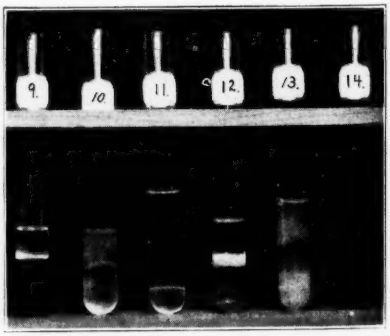
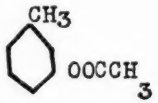


Fig. 8.—Drugs *9-14*, referred to in Figure 7.

Cresatin.



Cresatin is the acetic acid ester of metacresol. It is a clear, colorless liquid, stable and uniform in strength. It is slightly soluble in water. It is readily soluble in organic solvents. It is a penetrating, slightly oily liquid having a surface tension of 37.7 (Table 4.) It has a characteristic spicy odor which is rather persistent. It does not coagulate albumin and is not irritating to the tissue in full strength. It has an anodyne effect on living tissue. It is a surface tension reducent, and, in full strength, destroys

the organisms taken from an abscessed tooth in two and one-half minutes (Table 2.) If one part of benzene is added to one part of cresatin and diluted with fifty-eight parts of water, the phenol coefficient of the solution is 0.75. It is quite possible that its low surface tension and its ability to wet surfaces readily is the secret of its excellent clinical record. As it becomes hydrolyzed, there may be a very slow releasing of metacresol, which has a phenol coefficient against *Bacillus typhosus* of 2.4. The improvement in its germicidal effect by the addition of a small amount of benzene, which alone has very little germicidal action, is in accordance with the findings of Frobisher on the increased germicidal effect of germicides by the addition of inert surface tension reducents.

Table 4.—Germicidal Action of Drugs in Full Strength and Effect of Combining Cresatin with Benzene or Acetone

Phenol 95 per cent	Less than ten seconds
Acetone	Two and one-half minutes
Benzene	Two and one-half minutes
Cresatin	Two and one-half minutes
Hexylresorcinol Sol. S. T. 37	Less than one minute
Oil of cloves	Less than one minute
Trichlor	Less than one minute
Cresatin and acetone, equal parts	Less than one minute
Cresatin and benzene, equal parts	Less than one minute

CRESATIN IN ROOT CANAL TREATMENT

Cresatin is a very satisfactory remedy in root canal treatment. Every type of diseased pulp, from an aching exposed pulp to one chronically abscessed, has been treated with entire satisfaction with this drug. During the past year, it has been used in my practice in the proportion of three parts of cresatin to one part of benzene. Aside from reducing surface tension, benzene is a fat solvent, increasing the penetrating power of the germicide into crevices and dentinal tubules by dissolving fatty substances. Oils and fats greatly reduce germicidal action in that the fatty envelop protects the organisms from the germicide. Fat solvent properties are essential to thorough disinfection of inaccessible crevices and canals (Fig. 1). The slowly soluble property of cresatin gives it a prolonged action since the drug is not rapidly exhausted and the application may remain unchanged if necessary for several days, this depending on the amount of exudate. Its anodyne effect and its prolonged action, together with its satisfactory germicidal effect, give it a wide range of usefulness in root canal treatment.

SUMMARY

1. Important factors to be considered in determining the efficiency of a germicide for root canal treatment are contact, time and concentration, penetration into inaccessible canals and crevices, duration of effect and irritation to vital tissue.

2. Both laboratory and clinical tests must be made to arrive at a satisfactory conclusion as to the merit of a germicide.

3. Any factor that increases the penetration of a germicide into inaccessible canals and crevices is important.

4. Any factor that increases the number of molecules of a germicide in contact with an organism at a given moment increases its power to destroy it.

5. Diffusion and osmosis may be increased by lowering surface tension.

6. The action of fat solvents increases the possibility of penetration.

7. Drugs which coagulate albumin cannot penetrate deeply and are therefore not efficient germicides for root canal treatment.

8. Hexylresorcinol is a very powerful germicide, and is highly penetrating. It has a high phenol coefficient and a low surface tension. Its clinical tests confirm the laboratory findings and point to a wide range of usefulness in treating infections of the soft tissue.

9. Trichlor acts by virtue of its chlorin penetration and chemical combination with decomposition products, replacing hydrogen and releasing nascent oxygen. It is very efficient as a germicide for gangrenous pulps and infected root canal treatment. For other mouth infections, it has a wide range of usefulness in proper dilution. It may be used with confidence in its germicidal efficiency.

10. Cresatin has a low surface tension and readily wets the surface. It is slowly soluble and penetrates deeply into inaccessible spaces. It has a prolonged effect, and clinically appears to be nonirritating in full strength to living tissue. It has anodyne properties which widen its range of usefulness from exposed inflamed pulps to those which are necrotic and infected.

11. Oil of cloves, like other essential oils, contains irritating properties. It has a high phenol coefficient and low surface tension. It penetrates readily and has a prolonged effect. It has a history of long clinical use, but all laboratory reports do not agree on its efficiency as a germicide in root canal treatment.

12. Benzene has a very low surface tension and little germicidal value. Its solvent action on fat and its power of reducing surface tension of other agents, thereby increasing their action, appear to be its valuable properties. It should be used only in combination with other agents for treating root canals.

DISCUSSION

Carl J. Grove, St. Paul, Minn.: It would be interesting to know definitely what the results would be in the various stages of pulp decomposition with the presence of the products formed by the action of bacteria, and what the effect of the chemical reaction taking place in the breaking down of the elements composing these tissues would be, as well as the structural difference of the dentin, which would undoubtedly alter the action of these agents to some degree. It would also be interesting to learn to what extent these remedies would penetrate the tubules and act on the bacteria present in the dentin. Dr. Coolidge is one of the few men in the United States who have always believed that not all pulpless teeth should be extracted, and I wish to express my appreciation for the part he has had in the work of bringing many dentists to realize that all such teeth are not infectious. The study of germicides for the treatment of infected root canals is extremely important, and it is only through careful investigation that we will be able to make intelligent application of these agents. The prevention of reinfection of the dentin is a matter that deserves our attention; otherwise, treatment such as Dr. Coolidge has outlined would be of no avail. We must be able to seal the root canal at the dentinocemental junction, and if this is to be done, dentists must realize that it can only be accomplished by using impermeable materials for filling root canals. We must use materials that will not be altered by the forces present in the tissue. I have for some time used gold cones, or what might be better termed a gold root canal inlay. The forms of the gold used are standardized or gaged to the apical third of the reamers used in shaping the root canal. In other words, the root inlay is the same diameter as the reamers. Actual measurements of the length of the root as well as the diameter of the apical third of the canal have been compiled. The average length and diameter was determined from these findings, a chart showing the length and diameter of all the roots. From the chart,

one knows the length of the root to be operated on. I have also included in this chart the reamers indicated, thus avoiding the use of reamers much larger than the natural opening of the canal. The first step in this technic is to make a shoulder in the lower part of the pulp chamber by using an end cutting or inverted cone bur. In other words, the shoulder is made at the upper part of the root. The purpose of this shoulder is to furnish a rest for the reamer holder. The holder is made tapering to the size of the bur, which permits it to pass into the pulp chamber to rest on the shoulder. The body of the handle has a groove extending into the center, and on each side a vernier scale is made in millimeters, since all measurements of roots are in millimeters. When the reamer or the broach is inserted into the holder, the shank or the upper part of the reamer can be seen through the groove in the handle. This makes it possible to make a reading of the length of the broach and to lock it in the holder at any desired point, this depending on the length of the tooth to be operated on, information which is obtained from the reference chart. The broach is inserted into the canal until the holder rests on the shoulder, when a roentgenogram is taken with broach in position to determine whether the apex is reached. A fine smooth broach is always used to avoid injuring the periapical tissue. If the roentgenogram shows that the desired point has not been reached, we adjust the broach as the case may require, again insert it into the canal and take another roentgenogram. If the pulp is to be removed, a barbed broach is inserted into the holder to the same point as the previous instrument and the broach is inserted into the canal until the holder rests on the shoulder. Since all root canal instruments are made the same length, it is known that the apex is reached without making an additional picture, and it is also known that pulp is removed to the dentinocemental junction. The root inlay is also inserted into the holder in same manner and to the same point as the instruments. This technic makes it possible always to fill just to the dentinocemental junction.

J. R. Blayney, Chicago, Ill.: Dr. Coolidge has taken us another step forward in the scientific management of root canal therapy, and I hope that those who have heard today and those who will read this paper will put the suggestions therein into daily practice and not continue in the use of undesirable methods. The evidence presented is conclusive and as such is nondebatable. In the description of his technic, Dr. Coolidge said something like this: All pulp treatment is carried on in the presence of more or less organic material. That is true, and yet I am sometimes led to believe that many attempt such medication in the presence of the *more* rather than the *less*. That is to say, we are likely to underestimate the importance of a thorough mechanical cleaning of the canal, because, I suppose, too much confidence is placed or too much is expected of the drug used. I am impressed by and often refer to a quotation which is found just beneath the title of a leading text on "Materia Medica, Pharmacology and Therapeutics," which is: "Drugs sometimes cure, often relieve, but always console." I was particularly pleased to hear Dr. Coolidge mention the fact that many pulps may be necrotic in the pulp chamber or the first portion of the canal and at the same time be vital in the apical region, and then for him to insist that all such teeth be operated on without either infecting or producing a chemical irritation of the apical tissues. Undoubtedly, the failure to observe such precautions is responsible for a large number of unsatisfactory results. To illustrate: Some time ago, a careful check was made of a large number of clinical cases in which vital exposed pulps were removed without medication and instrumentation to destroy surface infection, and we found over half of the entire number treated were unsatisfactory. Dr. Coolidge has described the physiologic action and therapeutics of three remedies, namely, trichlor, cresatin, and hexylresorcinol. Trichlor is the only one with which I have had sufficient experience to venture an opinion. I have used this aqueous solution of chlorin over four years, and I have found it to be all that Dr. Coolidge has said. It is superior to the oil solution known as dichloramin-T. It may be used in the treatment of either vital or necrotic pulps without destroying the periapical tissue. We were told to beware of drugs that coagulate albumin for two reasons: first, because the precipitate limits the power of penetration, and, secondly, because of the danger of producing serious injury to the vital tissue within the apex. None of the chlorin-yielding compounds act in

such a manner, since all of the halogens destroy the protein molecule through the process of substitution rather than precipitation.

Dr. Coolidge (closing): Referring to Dr. Grove's remarks: During the past year, I have had occasion to make a considerable study of the pulp in relation to the building up of a secondary dentin or cementum or some form of bone substitution in the root canal, after the pulp is removed, which led me into a very interesting line of study, and as I went back over the literature, I found he had contributed many articles on his own investigations of that subject, and many fine illustrations that helped me greatly in my work and discussion of that subject. And now he brings to us something that represents another idea that perhaps is going to make a considerable impression, and that is his idea of casting a root filling. I don't know how limited that is in its application, but I shall look forward with interest to a complete published description of Dr. Grove's preparation of the canal and of the casting to fit the canal after removing the tissues from it and treating it and preparing it for filling. I do not think that the root canal problem is entirely dependent on a new material for filling root canals. A great deal depends on the thoroughness with which we remove the infection and the organic material from the canal, and then, of course, we must insert as nearly perfect a mechanical filling as possible. We are all interested in saving teeth. This subject is one of the most discussed even after all these years. There is very good evidence that the profession is not satisfied to remove pulpless teeth. Today, many are removed that should not be removed; many being removed that are not injurious to health, but just how to get that idea to the profession without having them go too far in the other direction is a difficult problem. We must learn how to diagnose, and determine what to extract, and then apply the things brought to us from the various laboratories. I have less fear today than I had five years ago about the safety of the root canal properly treated and filled. I have less hesitation of standing my ground today than I had five years ago.

MORPHOLOGY AND GROWTH OF FUSIFORM ORGANISMS*

By THEODORE B. VON BEUST, Louisville, Ky.

WHEN plodding amid the labyrinths of a research problem, the hopeful worker sometimes experiences a thrill. Not uncommonly, thrills constitute the student's only reward. While experimenting in 1905, in an attempt to disclose the morphology of the spores of *Leptothrix racemosa Vicentini,* I unintentionally divested of their enveloping mantle of stain the interior of certain micro-organismal clumps found in tooth felt. The ensuing thrill resulted in a number of publications,[1] in which the organism *Leptothrix falciformis* was described. These investigations have not, to my knowledge, been commented on. In view of the resemblance of certain developmental forms

*Work supported, in part, by a grant from the Research Commission of the American Dental Association.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventieth Annual Session of the American Dental Association, Minneapolis, Minn., Aug. 22, 1928.

1. Von Beust, T. B.: Arch. f. Zahnheilk., No. 5, 1906; Dent. Cosmos, 50:594 (June) 1908; Proc. Fifth Internat. Cong., Berlin, 1909; Dent. Rev., 26:117 (Feb.) 1912.

of *Leptothrix falciformis* to that which today is known as the fusiform bacillus, I decided, about three years ago, to recheck my work. Realizing that to science is granted the privilege of modifying views to conform to the light of added experience, I undertook the task without trepidation, but with much curiosity. Nothing in the work done more than two decades ago was found to conflict with my present views.

As the spores or conidia which grew on the stalk of *Leptothrix falciformis* appeared to be identical with the fusiform bacillus, a series of comparisons were first instituted to establish the affiliation, if any, of this organism with the latter form. Although the disagreement existing among authors concerning the morphology and staining properties of the fusiform bacillus is a factor making positive identification difficult, I published a statement in 1926,[2] and I continue to maintain that the falcate forms described by me in 1905, and subsequently, must be identical with the fusiform bacillus of early and contemporary observers. Further references were made to this subject in a paper read before the Seventh International Congress.[3]

The student of the fusiform bacillus would probably do well to dismiss, for the present, the thought that the fusiform organisms are bacteria. Rather, a generation of spores should be imagined which were developed from a parent which has affinities with the aquatic fungi. The diversified modes of propagation exhibited by both the fungi and

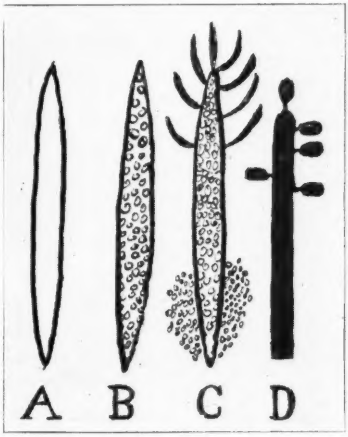


Fig. 1.—Diagrammatic drawing. *A*, fusiform bacillus; *B*, formation of endogenous spore bodies; *C*, appearance of the spores; *D*, attachment of spores of Leptothrix racemosa.

Fig. 2.—Camera lucida drawing showing a sporulating fusiform bacillus, together with fusiform organisms and spirochetes. (Each scale segment represents 10 microns.)

2. Von Beust, T. B.: Dutch Dent. J., June, 1926, p. 85.

3. Von Beust, T. B.: Morphology of Micro-Organisms of the Oral Flora, J. A. D. A., 14:389 (March) 1927.

microscopic algae obviate the necessity of any undue stretching of the imagination to find a parallel for the complex propagation of the fusiform organisms. If we are to ascribe to Nature's methods of reproduction any rationality whatsoever, that which I claim for the fusiform organisms is only a natural thing. For instance, there can be nothing extraordinary in reproduction during which a single cell undergoes nuclear division or fragmentation whereby it becomes metamorphosed into a sporangium and disseminates a multitude of spores. Such

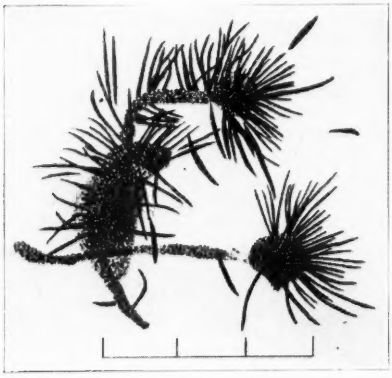


Fig. 3.—Camera lucida drawing (by M. J. Crawford). Iron-hematoxylin stain was used. (Each segment of the scale equals 10 microns.)

a behavior is relatively common, not only in the plant but also in the animal kingdom. One need only recall the sporulation of the sporozoa, the gregarinae, the coccidia, the pseudodopodiospore formation in ameba or the sporulation of some of the exoasci. A fusiform organism, then, while it appears to multiply by fission, may also, as shown in Figure 1, *A* and *B,* form a sporangium and give rise to a number of daughter organisms, as shown in Figure 1, *C.* Some of the occurrences during the progress of this sporulation must, at present, be conjectured, the diminutiveness of the component parts of the organism precluding a definite explanation at this time. While the daughter spores of *Leptothrix racemosa Vicentini,* Figure 1, *D,* are certainly, at some stage of their existence, attached by means of sterigmas, neither the mode of attachment nor the exact manner of exit of the daughter cells of *Leptothrix falciformis* has been ascertained. Much additional work will have to be accomplished.

Two kinds of spore bodies appear to exist. We find minute granules, as shown in Figure 1, at the lower part of *C.* These lie in a gelatinous material and often surround the parent body in countless numbers, forming a sort of a mantle. In addition, we find the falciform or fusiform type of spore body. Whether these forms occur simultaneously in the normal state is open to question, as numbers of specimens may be found that exhibit only one of the varieties.

For the study of these organisms, special staining methods are necessary. Very satisfactory has been the use of iron-hematoxylin (Heidenhain's stain), twenty-four hours being allowed for both mordanting and staining. Fixation adds to the results, concentrated aqueous picric acid being a very convenient fixative. The hematoxylin preparations show the organisms to best advantage for morphologic study. The sporulating organisms may be found in a variety of forms, some appearing as shown in the camera lucida drawing, Figure 2. Here, a bacillus of ordinary length has propagated itself in this manner. This specimen, together with a few of the surrounding fusiform bacilli and spirochetes, was

drawn to scale. To the uninitiated, the specimens often appearing are usually more difficult of interpretation. In Figure 3, we have two organisms drawn to scale by my assistant, M. J. Crawford. These show both the granular and the fusi-

4 to 14 microns, may also grow into threads. Before discussing the question of thread formation, I wish to remark on the photography of the stage of development here shown. Figure 4 is a photomicrograph of the two drawn

Fig. 4.—Photomicrograph of the specimen shown in Figure 3.

form types of spores. As the interseptal spaces on the scale equal 10 microns, it will be seen that the stems or parent bodies shown in this drawing vary between 35 and 45 microns, approximately. It follows that the fusiform organisms, which are popularly estimated at from

specimens. As may be seen, the peripheral bodies or conidia of normally stained preparations photograph very well. Not so the central core or axis. Detail here leaves much to be desired. We see here the so-called matrix of earlier observers. Owing to the density of the central

portions, much that is evident on ocular inspection is lost in the photograph. If we are willing to sacrifice detail to secure a photographic view of the interior, differentiation must be carried to an extreme and a weak filter used. Even then, results are far from satisfactory. Such a view is given in Figure 5, which represents a pale fuchsin preparation showing a short specimen. Figure 6 shows another extremely differentiated

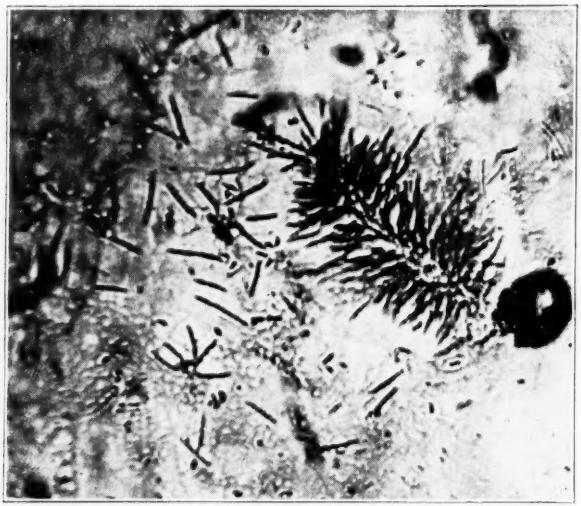


Fig. 5.—Photomicrograph showing sporulating fusiform bacillus. (Fuchsin stain; 2 mm. apochromat, oc. 2, tartrazine filter, extension 85 cm.)

organism, which was stained with gentian violet.

We will now select, for the purpose of observing the stem or axis or parent body, specimens exhibiting the final stages of development. Figure 7 shows us a camera lucida drawing that was made under a 2 mm. apochromat and with an ocular magnifying fifteen times. The stems, at this stage of growth, have lost their chrombphilic properties and, when well differentiated and devoid of adhering granules, appear almost perfectly transparent. Their protoplasm has apparently disappeared. They are irregular in diameter, portions of the stalks in some specimens being more than double the ordinary diameter. Stems exceeding five microns in width are found. Whether the cell diameter actually exhibits such measurements or whether such specimens are partly thickened by accumulations, it is difficult to discern. Stems more than a hundred microns in length are found. Figure 8 shows another unit which has lost most of its spores or conidia. The stem here exhibits beaded remnants of protoplasm lying in a transparent membrane.

As to the shape and length of the fusiform bacilli, we find the most varied descriptions in the literature. Their shape, when they are short, may best

be likened to that of a grain of oats. When on edge, they appear straight; when seen from the side, they are falcate or fusiform. As to their length, there is no limit. All transitions, both in length and morphology, may be found between the smallest fusiform bacillus and the longest threads. Figure 9 shows a variety of sizes, the longest in this field measuring 20 microns. Figure 10 shows further transition. This illustration, drawn from a well-differentiated iron-hematoxylin preparation, presents two types of threads. *A* is plainly and

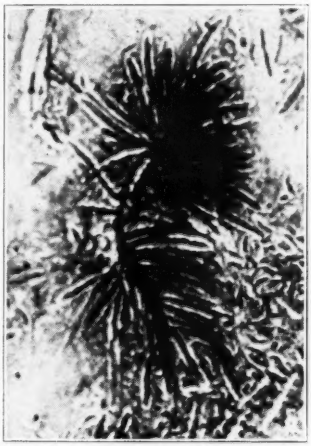


Fig. 6.—Sporulating fusiform bacillus stained with gentian violet.

beautifully septated, a dividing septum, described by me in 1909,[4] being visible between its segments. This type is, I believe, the *Bacillus buccalis-maximus* of Miller. Its pointed ends formerly led me to infer that this organism represented a stage in the life cycle of the fusiform bacilli. Today, I doubt that this inference was correct. Although I have seen indications of a septation of this kind in an analogous form from the mouth of the dog, I shall believe, until I have seen further evidence to the contrary, that the thicker, frequently mottled, more irregular and more definitely angle-worm type, without, or at best with poorly demarcated, septation, a septation which under ordinary laboratory methods is apt to be overlooked, belongs to the fusiform organisms (Figure 10, *B*). The accompanying organisms shown in Figure 10 lead up to it. Figure 11 shows threads taken from the same preparation. All of these probably belong in the developmental cycle of the

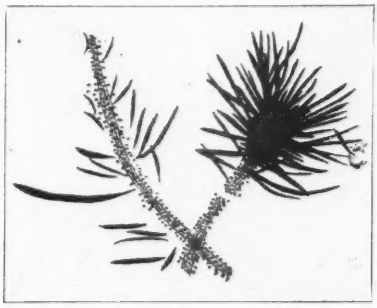


Fig. 7.—Camera lucida drawing of an end-stage in development. (Iron-hematoxylin; 2 mm. apochromat, oc. 15; reduced.)

organisms under discussion. Investigation into the mouth flora must be approached with an open mind. Those who lack ability to alter formed conceptions should turn to a less bewildering field. The difficulty of such research is increased by our inability to grow many of these organisms. I am here reminded that a number of investigators have claimed success in growing the fusiform organisms. I have consequently been criticized for not working with cultures instead of with smears. It appears to me that if we would posi-

4. Von Beust, T. B.: Dent Items Int., 31:99 (Feb.) 1909.

tively identify the contents of our test tubes, we must first learn to recognize the undoubtedly polymorphic mouth organisms in their native habitat. No one will be so presumptuous as to claim more than a very superficial knowledge of these organisms. Even W. D. Miller, who wrote a textbook on the microorganisms of the mouth, overlooked the most prominent form, *Leptothrix racemosa Vicentini;* nor had he any idea

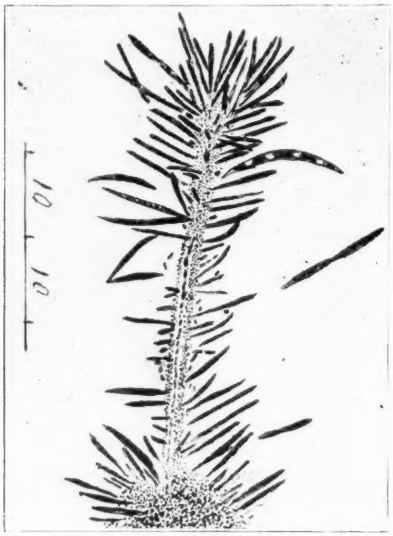


Fig. 8.—Camera lucida drawing showing beaded remnants of protoplasm in the stem.

of the pleomorphism which Vicentini so insistently asserted to occur. For these reasons, inferences based on cultures, notably biologic inferences based on experiments undertaken with cultures, for example, with *Streptococcus viridans,* appear rather gossamer; for such manipulations were probably carried on with commensals. The true etiologic agents, the numerically more frequent bacilli and spirilla which appear regularly in the smears made from septic foci about the teeth, fail, with equal regularity, to appear in the cultures.

There is a considerable mystery surrounding the early developmental stages of *Leptothrix falciformis.* Roughened and swollen threads, markedly chromophilic, as seen at *E,* Figure 11, probably represent this stage. Furthermore, threads covered with a mantle of granules, as shown in Figure 12, are found. These must exhibit a somewhat later

Fig. 9.—Various sizes of fusiform organisms, the largest in this field measuring 20 microns.

stage than the foregoing. In the earlier phases of its growth, *Leptothrix falciformis* must closely resemble *Leptothrix racemosa* (Fig. 13). Like the former, the latter appears to form a matrix of granules. The stems of *Leptothrix racemosa,* when stained with iron-hematoxylin, are apparently always devoid of septation and probably represent Miller's *Leptothrix innominata.* The stems are

more nearly uniform throughout, and are more flexible and less bulky than those of *L. falciformis*. The stems of the latter, on the other hand, are more stocky and more irregular and less chromophilic than those of the other organism. They are often septated. Then, there is, of course, the difference in the shape of the spores, and, in addition, the apparent difference in habitat, *L. racemosa* preferring the tooth crowns, where it occurs in clean and graceful clusters, while the *L. falciformis* seeks subgingival areas bathed in inflammatory discharges and is found covered with a tenacious mucus. Subgingival scrapings, removed from the teeth with a blade and disassociated in a drop of water by means of two pins, afford the most specimens. The sporulating stages of this organism have doubtless been seen, but not correctly interpreted, by every observer of subgingival deposit. Leber and Rottenstein,[5] in their excellent treatise on caries, doubtless, according to their descriptions, found these organisms in their smears.

However the question of affiliation of the forms here shown will finally be decided, the fact remains that the fusiform bacilli propagate by means of a peculiar type of schizogenesis, which removes them from the schizomycetes. Photomicrographs of these organisms may be studied in my former publications, notably in the *Dutch Dental Journal*.[2]

DISCUSSION

Phillip Jay, Rochester, N. Y.: I was very much interested in what Dr. Beust said about the fusiform bacillus. If it is true that fusiform bacilli are merely spores of *Leptothrix falciformis*, it will simplify matters a great deal for those of us who are working in bacteriology. I hope that Dr. Beust will try to grow those forms. The large stalk forms shown are very interesting. In studying dental caries and culturing carious lesions for *Bacillus acidophilus*, we often find yeast forms similar to those described by Dr. Beust growing in the same culture with *B. acidophilus*. I have tried to cultivate them, and I have separated them from *Bacillus acidophilus* and, observing it in pure culture, have noticed that the parent stalk is very similar to the one

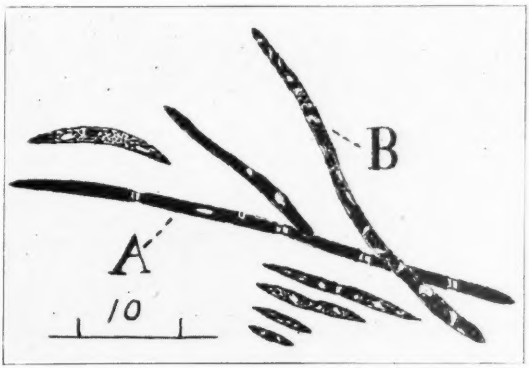


Fig. 10.—Camera lucida drawing. (Iron-hematoxylin stain.) *A*, a type probably representing Miller's Bacillus buccalis maximus. *B*, the result of elongation of a fusiform bacillus. (The segment of the scale equals 10 microns.)

5. Leber and Rottenstein: Research on Dental Caries, Berlin: August Hirschwald, 1867.

shown. It is very possible that there is a relationship. As all the stalk forms and leptothrix forms are so interesting, I think it is a very worth while work, and I hope to do more of it.

Edward H. Hatton, Chicago, Ill.: As I understand, Dr. Beust's work is a pure smear, not a cultural, method. We are hard pressed, in oral work, to find suitable mediums or suitable methods of growing mouth bacteria by artificial means. It is one of the most difficult problems there is, but we will never accomplish anything, as Dr. Jay has said, unless we do cultivate them in pure culture and then reproduce on the artificial mediums similar conditions in the mouth so that we can then show the forms almost, as he suggested, seriatim, that is, watch the development. In respect to the fusiform bacillus and its relationships, these forms that Dr. Beust has shown have been described by other people under different names. B. J. Davis of Chicago has described these forms under the general description of an actinomyces granule. Those of you who remember the organism of actinomycosis will see the resemblance to Dr. Beust's figures, and see how Dr. Davis got the suggestion that this was an actinomycosis-like organism. He explained this on the basis that the fusiform bacillus always grows in symbiosis, and particularly with the cocci forms. He has described clinical lesions in the mouth, the lungs and the brain, and on the genitalia; and he points out that, in the mouth, the lungs and the brain, actinomycosis is always associated with the streptococcus; while, on the genitalia, it is associated with the staphylococcus, and it reproduces the same lesion that is familiar in the mouth. He also feels that the thread forms of other kinds are the substance to which the fusiform bacillus and streptococcus are attached, so there is a symbiotic organism. He feels that the figures that Dr. Beust shows show a symbiosis, not what Dr. Beust presents. I offer this not in criticism but as another man's idea of the thing that Dr. Beust has described. Differences of opinion like this can only be ironed out by cultural methods. If Dr. Beust, by cultural methods, starting with a pure culture of the fusiform bacillus, can produce this actinomyces granule, he has proved his point; and until he can reproduce that figure, his contention must be in dispute.

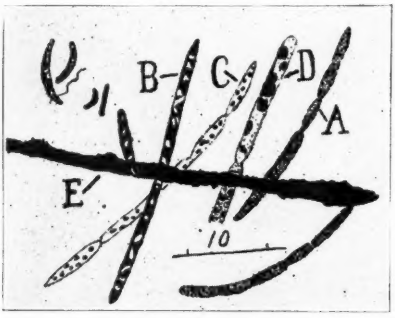


Fig. 11.—Transitions in the evolution of the fusiform organisms to the sporulating thread forms. (Iron-hematoxylin stain.)

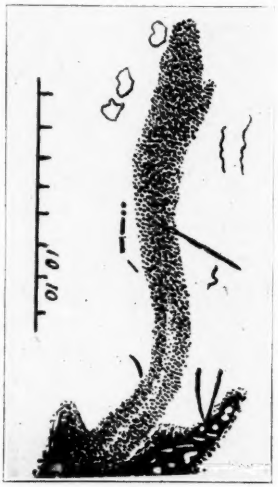


Fig. 12.—Mantled thread; a transitional form. (Iron-hematoxylin stain.)

Dr. Beust: I have frequently been criticized for not working with cultures instead of with smears. Beginning in 1910, I spent three years of rather intensive work in trying to cultivate these organisms. In my cultures, I secured a variety of threads, but in comparing them with those of the mouth, I could not satisfy myself that I had isolated the real organism. I then began

the study of smears under various methods of staining and differentiation; and I came to the conclusion that neither Miller, who wrote the textbook on the micro-organisms of the mouth, or any one subsequently, knew what the mouth organisms really looked like; so there was nothing left but to study the smears. Now, I have received cultures and studied the illustrations of several authors who have cultivated the fusiform bacillus, but I have not been able to satisfy

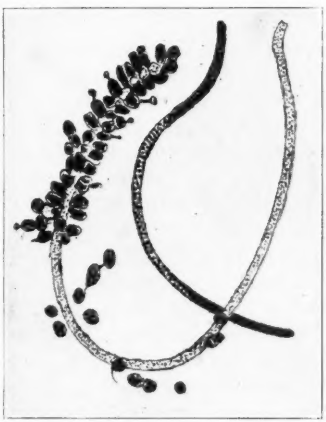


Fig. 13.—Leptothrix racemosa Vicentini. The naked thread represents the organism prior to sporulation. The other organism shows the final stage, after loss of most of the spores.

myself that these are identical with the fusiform organisms found in the mouth. In fact, I feel sure that they are not the same. To prove or disprove their identity will of course take some time. I think observers will have to agree on some stain. Iron-hematoxylin will show the structure better than any stain ever used by me. We will have to agree on a stain and all workers will have to contribute something to the problem. I do not believe that the organisms shown have anything in common with the actinomyces. The threads are morphologically different and the sporulation cannot be identified with that organism.

Dr. Hatton: I do not wish to be understood by either Dr. Beust or the audience as saying that this was an actinomyces. The organism was not actinomyces, but a deposit made up of more than one different organism, of which the fusiform bacillus was one.

Dr. Beust (closing): When Vicentini, in 1890, first described his *Leptothrix racemosa*, the connection of the granules or spores with the organism was questioned. Some contended that they were accidental epiphytes. Since then, so many have seen *Leptothrix racemosa* — Mummery, Williams, Percy R. Howe (Dr. Howe has also done some work in that line) and a number of French observers—that there can no longer be any doubt in the minds of those even superficially acquainted with the mouth forms that the granules do grow on its stalk. That being the case, nothing stands in the way of interpreting the pictures seen of *Leptothrix falciformis* in like manner. Many of these organisms can be found, and I would be glad to show preparations to any one—such convincing preparations, in fact, that students giving the matter unbiased attention must come to the conclusion that these spores actually grow on the thread. As to the identity of the spores of *Leptothrix falciformis* and the fusiform bacillus, that is, I think, yet an open question. However, the granules or spores which I have shown, together with the central threads, must be regarded as organic units.

THE VALUE OF EARLY DIAGNOSIS IN THE CONTROL OF CANCER*

By FRANCIS ASHLEY FAUGHT,† M.D., D.D.S. Philadelphia, Pa.

THE detection of cancer of the mouth and tongue is the dentist's duty; the prevention of cancer of the mouth and tongue, the dentist's opportunity.

Cancer of the mouth and tongue causes 3.2 deaths per hundred thousand of population in the United States. This is approximately 4,000 a year, or about 4 per cent of the total cancer deaths reported. Nearly all cases of cancer are met after the age of 40 years, but it should be remembered that occasionally fatal cancer has been detected in the twenties, and, very occasionally, even in infancy.

The usual signs of early cancer of the mouth and tongue, while somewhat varied, are generally characteristic and should be easily recognized. These include: (*a*) hardening or induration in a small area; (*b*) a warty thickening; (*c*) an ulcer that does not heal promptly; (*d*) a fissure that does not heal promptly, and (*e*) leukoplakia.

Cancer of the floor of the mouth or of the cheek usually begins with formation of white patches or an ulcer. When the edges of the white patch become indurated, elevated or ulcerated, the lesion has nearly always reached the cancer stage. Ulceration should be watched, and if, after simple treatment for two or three weeks, the affected area does not show a definite tendency to heal, malignancy should be suspected.

During treatment, strong caustics, such as silver nitrate, or other irritating solutions should not be applied, as, by this means, a simple ulcer or fissure may be stimulated to malignancy.

Cancer of the lip may begin as a local scaliness or a crust which, if picked off, rapidly re-forms. It may develop on the basis of a fever blister or a mosquito bite; or an injury may be the predisposing cause. At the angle of the mouth, a fissure may develop and fail to heal. Excessive smoking is a very common cause. Occurring in a position so easily seen, it would appear that early detection of the lesion should be the rule. Nevertheless, many cancers of the lip are fatal because of failure of either the patient or the medical or dental advisor to recognize the true and serious nature of the lesion until too late.

CANCER OF THE TONGUE

Cancer of the tongue may begin as a white patch or small ulcer usually adjacent to a rough tooth or plate, or it may follow a bite. In a certain percentage (from 17 to 40 per cent according to various authors), it begins on the basis of a syphilitic lesion. Any abnormal hardness in the tongue accompanied by elevation or ulceration must be considered an indication of malignancy unless

*Read before the Pennsylvania Association of Dental Surgeons, Nov. 13, 1928.

†Visiting Physician to the Misericordia Hospital, Philadelphia; Member of the Committee on Cancer Control of the Philadelphia County Medical Society.

proved otherwise. Lymphatic involvement is rapid.

The characteristic carcinomatous ulceration has an excavated base and infiltrated edges and is moderately painful. Often, its first symptom is pain in the ear. When very small, these cancers are still in the curable stage, but infiltration is rapid, because the tongue is simply a bundle of muscles, the frequent movements of which mechanically squeeze the cells throughout the tongue's structure. The deep nodular variety may infiltrate before it ulcerates.

Glandular metastasis occurs early. Sometimes, it is the first symptom of the disease, especially in the deep nodular type of cancer. The glands involved are the submaxillary, the superficial and deep cervical. Lymphatic anastomosis between the two sides of the neck may result in early bilateral glandular involvement.

As the rich lymphatic system of the neck usually prevents the disease from breaking through, distant metastasis is infrequent.

CANCER OF THE TONSIL

Cancer is one of several diseases that produce chronically enlarged, painful and ulcerated tonsils. Cancer in this region usually begins as a "sore throat," in most cases developing gradually; occasionally suddenly, like acute tonsillitis. The pain may not be great nor the swelling large, but it is always unilateral. Most other conditions affect both tonsils; if not immediately, very soon. We should be suspicious of unilateral tonsillar disease. Any condition of the tonsils persisting for more than two or three weeks should be considered malignant until proved otherwise. Biopsy is the most reliable means to diagnosis.

CANCER OF THE PHARYNX

Cancer of the pharynx usually follows chronic irritation, as from smoking. The complaint is that of a sore throat which comes on gradually and persists; later to be followed by induration. The ulceration is generally quite sharply localized, and should easily be recognized by a competent diagnostician.

The importance of a high standard of mouth hygiene cannot be overemphasized. There is no instance on record of a mouth cancer developing unless the mucous membranes have first been injured or broken. Cancer may occasionally follow a sudden injury, but is generally caused by some chronic irritation, usually bad mouth conditions, which include every feature of dental decay, teeth with broken and jagged edges, teeth out of line but otherwise normal, pyorrhea, chronic inflammation about the roots of the teeth, chronic root suppuration and the presence of ill-fitting dental plates, bridges and crowns. All of these act to maintain in the mouth two important predisposing conditions: (1) chronic irritation and (2) chronic infection.

Irritation frequently results from the excessive use of tobacco, either smoked or chewed. Tobacco users add to bad teeth a most effective factor in producing cancer of the mouth. Tobacco is not only directly irritating but it also prevents wounds and abrasions from bad teeth from promptly healing. Eliminate these factors and cancer of the mouth will disappear.

It is especially important to be constantly on the watch for precancerous conditions, such as simple papilloma and warty growths. When they are encountered, their removal should always be recommended.

Simple ulcers and fissures should be relieved of all possible sources of irrita-

tion, and if, in a short time, they show little or no tendency to heal, they should be regarded as possessing signs of malignancy.

LEUKOPLAKIA

Leukoplakia is a white patch or patches involving usually the dorsum of the tongue or the cheeks. These patches may be small or may cover large areas.

Leukoplakia is essentially precancerous, and its progress should be arrested, whenever possible, by the removal of all sources of irritation. This includes the use of tobacco, which is a prominent factor in the development of leukoplakia.

The Wassermann test has demonstrated that the syphilitic theory of the origin of this condition is no longer tenable, the reaction being positive in not more than 25 per cent of cases.

When this condition undergoes malignant change, there is at first a thickening of some part of the patch, which later becomes excoriated and elevated, finally ulcerating and infiltrating the deeper tissues.

Even after leukoplakia has developed, the removal of all irritation, as from rough and sharp teeth, chronic infection at the cervical margin and accumulation of tartar, may cause the condition to retrogress.

Tuberculous infiltrations and ulcerations and primary and tertiary syphilitic lesions are important chiefly from the standpoint of differential diagnosis. Tuberculous areas in the mouth are rarely indurated and are usually associated with signs of tuberculosis elsewhere, as in the lungs or in the pharynx.

Chancres are of comparatively rapid development and glandular involvement is prompt. Microscopic examination of the exuding serum should reveal the treponema; while, after a short time, the blood Wassermann test will become positive. Tertiary lesions are more difficult to recognize, as gumma developing in the body of the tongue will greatly resemble deep, cancerous infiltration, and since old syphilitic lesions predispose to the development of cancer, one should be on guard, always remembering that a positive Wassermann reaction does not rule out cancer, nor does a negative Wassermann reaction eliminate the possibility of syphilis.

If we wish to improve our cancer statistics, we must recognize the great importance and serious significance of precancerous lesions and direct our attention to their removal before they have a chance to become dangerous. The onset of cancer is insidious and is accompanied by few and unimportant symptoms. As pain is frequently absent, we must be constantly on the lookout for those conditions which are recognized as predisposing to the development of cancer and for the slightest evidence of any reaction of the tissues suggesting cancer.

The present state of our knowledge of cancer is not sufficient to permit the formulation of such procedures for the suppression of this scourge as have been successfully employed for the control of infectious disease. Nevertheless, there are enough well-established facts and sound working information concerning prevention, diagnosis and treatment of cancer to save many lives, if this information could be universally applied.

The cause of cancer is not completely understood, but there is no evidence that it is contagious, infectious or hereditary.

Primarily, our ability to cure cancer depends on the stage at which it is discovered. If seen early enough and promptly and efficiently treated, practically all cancers are curable, but there

must be no delay, and we must have the hearty and intelligent cooperation of the patient, not only during the immediate period of treatment, but also during a long follow-up period.

Successful treatment is difficult and often impossible in the presence of extensive involvement, especially if metastasis has occurred.

Cancer in some regions should be discovered easily and promptly, and fortunately most cancers in the region of the mouth are in this group.

The internal administration of drugs and the application of pastes, or the injection of serum, or reliance on Christian Science, are not only useless, but also dangerous, since, if they do not hasten the progress of the disease, the time devoted to their use may allow the disease to progress until it has reached a point where the best treatment is hopeless. The only known safe and efficient method of treatment is the immediate and complete removal of the growth by means of the roentgen ray, radium, electrocoagulation, dessication or surgery, either used singly or combined.

In the fight against cancer, dentists should not confine themselves to evidences of this disease within the buccal cavity. Their periodic meetings with their patients often give them knowledge of signs and symptoms suggesting cancer in other regions. Therefore, if dentists will grasp every opportunity to obtain reliable information regarding signs and symptoms of cancer elsewhere, they may be able, by a timely word, to direct patients showing evidence of cancer to a physician for examination, diagnosis and treatment.

CONCLUSION

1. Enough is now known regarding the prevention, arrest and cure of cancer to reduce mortality materially if this information could be universally applied.

2. The curability of cancer depends on the region in which it develops and on the stage at which it is detected.

3. All cancers are curable provided they are treated properly and early enough.

4. The only known sure method of treating cancer is complete eradication by the roentgen ray, radium, electrocoagulation or surgery.

5. The true cause of cancer is not known, but it rarely, if ever, develops except after chronic irritation.

6. The most successful way to prevent cancer is to treat or remove those conditions which lead to the development of cancer before it has had an opportunity to develop.

7. The dentist, in this campaign for the prevention and control of cancer, is able to assist to the extent of searching for cancerous and precancerous conditions in and about the mouth, and by keeping the mouths of his patients in such a state of health as to make the presence of chronic irritation or infection impossible.

8. Dentists should seek competent advice in every case in which there is any doubt as to the true nature of the pathologic condition found.

WOOD APPLICATORS AS A FACTOR IN GINGIVAL MASSAGE*

By PAUL A. EDMAND, D. D. S., Chicago, Ill.

MANKIND has always been afflicted with disease, the most prevalent being that of the teeth and gums. A great many diseases have diminished in severity in our day, but mouth conditions have become worse.

Many forms of treatment and stimuli surgical and otherwise have been advocated whereby an abnormal condition of the supporting structures and surrounding tissues of the teeth may be made normal or nearly so. Some treatments recommended are quite simple, while others are complicated, and when not in the hands of experienced operators, conditions have been only aggravated.

We are living in the age of speed. Brevity in action and good results are the factors with which we deal. However, in their employment, we must not jeopardize nor neglect our objective. In giving you this report, I have only one object in view, and that is the recommendation of a simple stimulus to the gum tissue which will meet the foregoing requirements. I have attempted for several years to instruct patients to brush the teeth and at the same time stimulate the gingiva, and while my results have been encouraging in some instances and I do not question the benefits derived from brushing myself and the patient equally treatment when I am actually doing the brushing myself and the patient equally enthusiastic about a result will cooperate, I am not satisfied with the use of the toothbrush alone.

A check-up on my patients over a period of twelve years reveals that about 10 per cent actually brush the teeth with an intent to stimulate the gingiva. Yes, they *all* brush, but not as it should be done. The reason for lack of results, I find, is that they do not spend enough time in the procedure. However, I have not given up the use of the toothbrush, and I am still advocating the system of getting the bristles between the teeth, using a vibratory motion, but the time required actually to accomplish this manipulation properly is so great that I have substituted an agent whereby a result can be produced more easily and accurately, with less time, and one that the patient will really use.

Before trying or recommending any certain technic relative to bringing an abnormal condition to a normal, one must have some conception of the structure to be dealt with and its characteristics; hence, a word concerning the anatomic and histologic construction of the gum tissue. I have always had concern for the interproximal spaces of the teeth together with the contact point and all that it implies, but time does not permit me to dwell on all the specific needs of this area. In passing, I ask that they not be overlooked, for I shall confine myself

*Read before the American Academy of Periodontology, Minneapolis, Minn., Aug. 17, 1928.

merely to stimulation of the surrounding tissues.

The red firm tissue continuous with the mucous membrane of the vestibule, on the one hand, and with that of the palate and floor of the mouth, on the other, covering the alveolar borders of the maxilla and mandible and surrounding the necks of the teeth, is known as the gums or gingiva. The gums are composed of dense fibrous tissue inseparably united to the periosteum and covered by mucous membrane. They are richly supplied with blood vessels and are covered by stratified squamous epithelium or, if you please, pavement epithelium. At the base of each tooth, the gum forms a free overlapping collar closely set with small papillae visible to the naked eye and usually from 1 to 2 mm. in thickness. The connective tissues of the gums are continuous with the alveolar periosteum which accurately binds the root of the tooth to the alveolus making the tooth a fixed organ.

The tissue which we are interested in is known as pavement epithelium, and when Nature found it necessary to form this kind of tissue about the necks of the teeth, she had one idea in mind: There would be a certain amount of friction in this particular location. The histologic study of pavement epithelium, especially its characteristics, is very interesting. The superficial layers consist of flat cells, while the lower strata are more columnar. The surfaces of the cells which the cement substance connects are often quite smooth, but sometimes show inequalities and depressions due to the pressure exerted one upon another. This is especially applicable to gum tissue in the mouth. The epithelium itself, as a rule, possesses neither blood nor lymph vessels. Capillary branches have been found in the epithelium. The very constituents of the gum tissue, with its base of highly vascular fibrous tissue are easily taken care of when the right care is applied.

REPORT OF CASE

In a case which came under my care a year ago, there was a discharge of pus together with hypertrophy of the gums extending beyond the contact point on the buccal-lingual and labial-lingual sides of the teeth. The alveolar process showed atrophy, with granulomatus tissue—a typical case of periodontoclasia. No other particular kind of treatment was authorized at this time other than that the patient was instructed in the use of a round polished toothpick.

The technic employed was as follows: Selecting a round polished toothpick, we began in the interproximal space at the median line, placing the instrument at right angles to the tooth itself, applying a gentle, but firm pressure on each interproximal space, just enough to give the feeling of tightness, as of a wedge. We have found that, by beginning at the median line and working toward the molar region, the applicator becomes more pliable and can be bent at an angle to make this region easier of access. This was repeated four or five times in each interproximal space. Twisting was not advocated. The patient was carefully instructed in the technic and was required to carry this out five minutes each day.

After the lapse of a few days, with the cooperation of the patient, still greater pressure could be applied, until the patient remarked about the pleasing sensation. In less than one month, this case was entirely normal and has so remained.

I have many patients at the present time cooperating with me in the use of the toothpick, but the foregoing case is one that I have studied histologically, watching the tissues change from an abnormal to a healthy condition.

The prognosis as regards the use of a wood applicator is most favorable. There may be arguments against its use, but when I compare the cases in which the toothpick and the brush were used with those in which only the brush has been

used, I must admit that the use of the former is more beneficial. Why? Simply because the stimulation thus applied to an epithelium and fibrous tissue means increased circulation and an increased number of cells. This building up of cells is characteristic of Nature throughout the human body, especially where stimulation occurs as the direct result of a mechanical application, be it in the mouth where contact is had with coarse food, toothbrushes or toothpicks, or in the palm of the hand stimulated by a golf stick.

In the beginning of this article, I said we live in the age of speed, and when I apply the word speed in the care of the teeth and supporting structure, I mean that a patient instructed in the proper use of a toothpick does not need to spend so much time as in the use of the brush, and can still obtain a better result. Results are what count and my reporting of this case, *modus operandi,* etc., is done with the idea of giving something simple to our patients in home care as well as something to be considered in our own work in periodontoclasia.

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Editorials

IS THERE ANYTHING WE REALLY KNOW?

This seems to be an age of iconoclasm, and not a thing in the world is sacred. Neither is any theory or belief safe from suspicion or attack even though it may be entrenched in the strongest tradition. Perhaps this is well. Many of the things that we have come to take for granted are found to be vulnerable the moment they are subjected to close analysis, and we are constantly obliged to revise our point of view. Change is the order of the day, and to achieve progress, we must have change; but all change is not for the better, and it is just as important for us to maintain balance and preserve the good as it is to constantly change and tear down the bad.

After all, we have not been wrong in everything we have attempted up to date, and it does little good to label our every belief as erroneous. We are not entirely certain of everything that we believe today, but we are certain of some things. To claim otherwise is a direct reflection on our intelligence, and a terrible arraignment of man's reasoning power.

These observations are brought about by some recent pronouncements on matters that concern us as dentists, and with which we must reckon. One of these is the propaganda that is being launched in favor of sugar as a food material. Not content with a legitimate statement of the value of sugar as a food, "an eminent British medical authority" (name conveniently omitted) has recommended sugar for the teeth in the following language: "Sugar, perhaps more than any other food, tends to promote the flow of saliva in the mouth, which should be conducive to preserving the teeth in a clean state." He also says: "Eat enough nourishing food, and remember that sweetness is nature's perfect flavor. Nothing can take the place of sugar in making the whole meal enjoyable. Eat some citrus food—sweetened to taste—at least once a day."

Well, maybe so. We have no scientific data at hand to combat the idea that sugar is good for the teeth, and all of our preconceived ideas that it is injurious may be wrong, but on reading articles of this type we may be pardoned for the suspicion that they smack more of propaganda on the part of commercial interests than they do of scientific accuracy on the part of professional men. If sugar is beneficial to the teeth, then we as a profession have been doing a definite harm to the people in our attitude toward sweets. We are led to wonder what we really know, and yet when we see masses of sticky candy around the decaying teeth of children we cannot bring ourselves to lose much sleep through a troubled conscience over the fact that we have warned our patients against the use of too much sugar—"an eminent British medical authority" to the contrary notwithstanding.

Another recent bit of excitement has been launched—this time also by a medical man—to the effect that amalgam as a filling material is injurious to dentists and to their patients through the evaporation of mercury. This is not by any means a new pronouncement. Periodically, this idea bobs up, like Banquo's ghost, only to subside again after a given amount of steam has been blown off over it. Of course, we must recognize the fact that certain individuals are extremely susceptible to the influence of mercury, as is the case with other instances of idiosyncrasy, but if all the dire effects that

have been charged against amalgam fillings were true, many of our dentists and most of our patients would have been dead long ago. To show the extreme to which imaginative people may go in such matters as this it may be illuminating to refer to two circumstances. One was the assurance given to the Editor years ago by a dear old lady that she was so susceptible to the influence of mercury that if a waiter at the hotel had an amalgam filling in his tooth, she could detect it at once, and was deleteriously affected by it.

The other was the statement by the medical man who recently wrote on this subject to the effect that "even gold fillings may contain mercury in amounts sufficient to cause symptoms."

We are sometimes prone to raise a question as to what we really know; but using these two circumstances as an illustration, we can safely say that we do know that mercury could not perform the acrobatic feat of somersaulting from an amalgam filling in the tooth of a waiter at a table and injuring a dear old lady having her meal; and we do know that there is no mercury in a gold foil filling —so what is the use of argument?

AMBITION

Healthy ambition is a tonic; perverted ambition is a disease. Ambition of the right kind is laudable; ambition of the selfish sort is something worse than unworthy—it is pernicious. Ambition is at one time a benefaction and blessing; at another, it is a curse.

Had it not been for ambition on the part of certain men, the world would never have advanced as it has, and if ambition had not dominated other men, many worthy enterprises would have been carried to full fruition which today lay wrecked beside the pathway of progress. Ambition is a faithless jade when given rein along unworthy lines, and leads to more disaster than success. There is no other one influence that has wrought so much good and so much ill as this.

Without ambition, the ablest man falls short of doing much that is worthy. It is the mainspring of many a great achievement, and the power behind a myriad of noble efforts. If a man has the

ambition to serve faithfully and efficiently in every good work; if he longs to outdo other people in kindness, in charity, in generosity; if he has the ambition to excel in true and loving service, there is no other impulse in life more commendable. But if his ambition finds expression in a love of power; if he seeks merely to overcome his fellowmen, to gain influence, prestige or acclaim; if he has the ambition to own more dollars than other men so that he may make a bigger display; if it is his ambition to lord it over his associates and make them sycophants at his feet; if he loves to make men bend the knee in his presence; if he has any unworthy purpose behind his ambition, it were better that he had none. A man who is a nonentity would be a greater asset in the world than one having an unworthy and dangerous ambition.

One of the most conspicious examples of ambition among men is that which impels them to desire political prominence. Unless there is behind this desire a real intent properly to serve the community, and to do this at some sacrifice, it would be preferable as far as the community is concerned, and even as far as the politician is concerned, if ambition had never entered his heart. There is something fundamentally wrong and unstable in any situation among men where ambition leads to an unworthy purpose. Ambition is a most dangerous influence unless wisely directed, and its baneful effects never stop with those who are apparently most affected by it, but remain ingrained in the very fiber of the man who has the ambition. Unworthy ambition slays its victims by the million. It is worse and more disastrous than any physical disease that affects the human family. The striving and struggling among men to gratify an ambition is debilitating and demoralizing. It paralyzes honest effort, and puts a false value on estimates; it really has to do with the nonessentials of life. It flaunts its gaudy banner before the multitude, and hides in the darkest recesses of the human brain. It fosters plots and deep designs, and energizes the unworthy impulses of the unprincipled and the schemer. Ambition not only sinks its dart in the heart of honor, but even crushes under its cruel heel the sacred flame of love. When ambition rules supreme, there can be no noble motive in the minds and plans of men.

It distils from its subtle tincture the essence of meanness and envy and hate; and brews from its reeking caldron the baneful dregs of distrust and doubt and fear. It sows the seeds of sorrow and waters them with the tears of broken hearts. It grows in the miasma of its fruitless soil the pernicious weeds and burs of wrong, and pins a badge on the breasts of knaves and fools.

Ambition spreads its blight over the fertile fields of hope and cheer, and whithers the most promising projects of men. The foolishness of ambition is one of its most patent faults, and hidden away in the folds of its nether garment is the germ of humiliation and chagrin. To be too ambitious, or to have ambition in a doubtful cause, is worse than playing with fire. Fire consumes and purifies, ambition only chars and leaves intact the cinders of regret. Disappointed ambition turns and rends its victim like an inward claw.

To suffer defeat in the ordinary affairs of life is nothing; to have ambition baffled is to gnaw the vitals of pride and hope. The debilitating effect of thwarted ambition has palsied many a promising enterprise, and has turned joy into despair, and courage into fear. Hidden away in every human heart is an ambient spark ready to spring into fame. If touched with worthy motive and pure intent, this spark is sacred and filled with the possibilities of celestial light; if dampened by base design and ulterior purpose, it reeks with the fumes of the bottomless pit. Every individual must choose the manner in which this spark is fanned—each in his own way. It is the privilege of every one to make of this spark an illuminating flame or a devastating will-o'-the-wisp. That is the glory of our sovereignty: to us it is given to be worthily ambitious and come into the fullness of our destined heritage, or to sink in the slough and mire of base design and thwarted intrigue, and go down to disappointment and defeat.

FORGET IT!

If a man slights you, forget it. If he lies about you—unless it is something fundamental—forget it. If he talks about you behind your back, forget it. Always remember that the maligner suffers

more from maligning other people than the people maligned. It doesn't pay to waste energy in resentment when you feel yourself wronged—just forget it. A man achieves more triumphs by going serenely on his way in the face of calumny, misrepresentation and perfidy than by hitting back and retaliating in kind. The biter is always the one who is bitten. Injustice is sometimes hard to bear, but the surest and quickest way to overcome it is to forget it. The man who can smile in the face of opposition is the one whom opposition never hurts. If you find yourself misunderstood, and your motives questioned do your utmost to make people see the light, but if you fail in this and they become wilfully perverse, do not expend useless effort—forget it. This is often a good philosophy of life when more complicated measures fail.

JOHN P. LUTHRINGER, D.D.S.

(1868-1929)

John P. Luthringer died suddenly at his home in Peoria, Ill., Feb. 22, 1929. He was born in Petersburg, Ill., Sept. 6, 1868, and was the son of Francis X. and Barbara Luthringer. He attended Illinois College, and later the School of Pharmacy at Northwestern University and for fifteen years he was in the drug business in Petersburg. Later he studied dentistry, graduating from the Chicago College of Dental Surgery in 1899. He began the practice of his profession in Peoria and eight or nine years ago started specializing in roentgen-ray work, confining himself to this branch and gaining a wide reputation as a specialist. He was a life member of the state dental society and of Omicron Kappa Upsilon, honorary dental fraternity. He had been in poor health for several years, but had kept on with his work regardless of his condition.

Dr. Luthringer was widely known in the dental profession. From 1917 to 1920 he was secretary of the state dental society, and served in 1920 and 1921 as president of the society. He had served the Peoria County association as librarian, treasurer and president. He was a member of the Knights of Columbus and was the first master of the Peoria district. He was formerly a member of the Kiwanis Club and the Creve Coeur Club but had withdrawn from both organizations because of ill health. The past two summers he spent abroad, in Norway and Sweden. He had never married.

He is survived by two sisters, Miss Emma Luthringer of Petersburg and Mrs. Henry Klaholt of Springfield, two brothers, Frank and Will J. Luthringer, and a number of other relatives.

BUREAU OF DENTAL HEALTH EDUCATION

HOW THE WILSON STUDENTS REACHED THE ONE HUNDRED PER CENT GOAL IN GOOD TEETH

By HENRIETTA FRANK, Cedar Rapids, Iowa

WE hear so much today about creating a good English conscience, but in the Wilson Junior High School in Cedar Rapids, Iowa, we are endeavoring to create a "good teeth conscience."

My interest in good teeth was aroused while I was a student at the University of Chicago. An infected tooth compelled me to discontinue my college work and undergo an operation on my jaw bone. As a result of this, it became necessary to have a treatment every day for a year. Because of this experience, I became keenly interested in children's teeth. I did not take an active interest until six years ago, when I visited in New York City and attended a baseball game at the Yankee Stadium. Here, I saw Dick Whitehill, pitcher for Detroit and a former pupil of mine, fan Babe Ruth and put Detroit at the head of the American League. This gave me a real thrill, and I decided then that the children in the community where I taught were capable of doing big things, if only I were capable of inspiring them. Dick, by the way, has excellent teeth, which no doubt partially accounts for his splendid physical fitness and athletic ability. I decided *then* to make "good teeth" my hobby.

When I returned to school in September, 1924, I launched a good teeth campaign. At that time, I had charge of the physical training of both boys and girls at the Van Buren Junior High School in Cedar Rapids, Iowa, which had an enrollment of 400 pupils. Since it was a little project of my own, I did not ask the home-room teachers to help. I knew that they were in sympathy with the campaign, and would willingly cooperate if necessary.

The success of any educational campaign is determined largely by a teacher's vision, vitality and inspiration. Children can't be compelled, but must be inspired into appreciation of good health. The best teachers today are helping children to see that health is not only learning things but doing things. "To cure is a voice of the past, to prevent is the divine whisper of today." Parents who believe that children should go to the dentist only when they have the toothache must have their point of view changed.

In putting across any project, the teacher must be fired with enthusiasm concerning the thing that she wishes to put across. The teacher must sell the idea to herself first. Then she can sell the idea to the children, who will win the parents. For what parent does not crave good health for his child?

In a campaign of this kind, one must always make plans to stimulate the chil-

dren's interest, must kindle a spirit of rivalry between the classes. Then one must have faith and ability to see the project through.

I find that I am successful in getting a favorable reaction on the part of pupils by using slogans. These slogans help me also to "carry on." Our first slogan during the campaign was "Remember that American ends in I can." This slogan creates the positive idea and reminds us that we can accomplish anything that we desire if we think that we can; provided, of course, we have backbone rather than wishbone. I must confess that many times during that first year, I doubted the truth of this slogan. Our second slogan was "Be a participator, not a spectator." This gives the students the idea that the game of health cannot be played from the sidelines, that one must actually participate in the game in order to derive benefit to himself. Our third slogan was "There is only one way to spell business, it must have a U and an I in it." This slogan makes the students feel that they are all members of a large business firm with a definite aim. It emphasizes the fact that a campaign costs something, and in order to make it a success, we must all render service.

The initial step in the good teeth campaign was a talk with the pupils concerning the campaign. This was a test of my salesmanship. The next step was examination of the teeth. On examination, I found that few children cared for their teeth. I consulted an expert dentist, who gave me some good advice. I demonstrated to the pupils how to clean their teeth. This I did to create a desire for clean teeth, for some of the children had never experienced this feeling. "Oh, what a grand and glorious feeling," as one boy expressed it. "My teeth are so slippery now that they are a regular skating rink for my tongue."

Next, I called on the leading dentists of the city and asked for their cooperation because the question of finance was a serious one in some of the homes in our community. The dentists of Cedar Rapids, Iowa, wishing to serve all children, reduced their charges whenever the need was evident.

In Cedar Rapids, the junior high school students do not have access to a school dentist. If we send a pupil to the dentist, we must assume the responsibility for the payment of the bill. Because we wished to make each child feel a certain responsibility for the success of this campaign, we organized a "good teeth service club." Membership in this club was wholly voluntary. In order to belong to the club, each member must participate in some way in helping to finance the campaign, that is, to earn money to pay the bills of his worthy classmates whose fathers were out of work, or who, because of illness or unfortunate circumstances, could not assume the expense. Every child in our junior high school has always belonged to the club. When once a member of the club, each was allowed to do as much as she desired for her worthy pals. We entered many lines of business in order to raise money to pay dentist's bills. We sold jello, vegetables, popcorn balls, kolaches, old paper and Eskimo pies, and also put on physical training demonstrations.

Several girls who brought their O. K. slips the first week of school sold fifty packages of jello and brought great bundles of discarded magazines and papers, which were sold to help meet our financial obligations. No child considered her duty done because she had her own teeth fixed. Not until every child had her O. K. slip in was the work of the club fin-

Group of Woodrow Wilson Junior High School girls with May basket of "O.K." cards, each of which indicates the perfect mouth condition of its student owner. This school has had a 100 per cent good teeth record for five years.

ished. Students who were to receive help worked right along with their friends who were helping them, all inspired by our school slogan: "Whatever we do, we all do, and we all do it together."

In order not to give children the idea that we wanted their teeth fixed just so the school would be 100 per cent, we placed huge posters in the corridors saying —"Good Teeth Mean Good Health—Good Students—Good Athletes and Good Looks." All of these help to bring happiness and, after all, that is what we are searching for in this world.

An attractive good teeth honor roll was placed in the main corridor. As soon as a child brought his O. K. slip, his name was recorded on it. In this same corridor hung a tooth thermometer chart which showed the percentage of O.K. slips in each room. The children's chief indoor sport was watching this tooth thermometer rise.

Exercise and care of teeth were encouraged by frequent discussions and by the use of manufacturers' samples. Various breakfast food companies sent to us samples of their products to emphasize the kinds of foods that build good teeth and several dentifrice firms sent miniature tubes of paste to introduce to the children cleansing and antiseptic remedies.

Every Friday during the first year, a short assembly was held and a silver trophy cup was awarded to the room having the highest percentage of O.K.'d teeth. At these assemblies, we sang songs about teeth and we gave yells about teeth, and children and business men gave speeches about teeth. In fact, we tried to convince the children that nothing was impossible with "good teeth."

I cannot begin to tell you in detail the various schemes that I employed that first year to arouse and hold the interest of the children in this campaign.

Every teacher must get a new vision each day. It is this growing aspect that does the work. It is the feeling of responsibility that makes one rise to meet the situation.

You will discover that it takes an enormous amount of tact, patience and sticktoitiveness to put a tooth campaign across, but the value to the children is worth all the effort. You will find this health game the most exciting and thrilling game that you have ever played. Some of the most noticeable by-products of this game are improved scholarship, citizenship and school spirit.

With the cooperation of principal, teachers, parents, pupils, dentists and business men, our vision of O.K.'d teeth for every boy and girl in Van Buren Junior High School became a reality. We started the "Good Teeth Campaign" the first day of school, and we arrived at the 100 per cent goal the last day of school. It had taken us exactly nine and one-half months to accomplish this feat. Oh, what a thrill it gave us actually to experience the joy of accomplishment. When the last O.K. slip was in on the last day, we called an assembly. Parents, dentists and business men joined with us in celebrating our good teeth victory. Interest in this good teeth movement was not confined to the Van Buren community. This was considered a civic project. The city paper featured us in their Sunday edition, giving us an entire page with a picture of all the students entitled "A Panorama of Clean Teeth." The headlines were, "Good teeth movement started last fall in Van Buren Junior High School ends in glorious success. This movement means much to the citizens of Cedar Rapids."

The next year, we moved to our new home, Wilson Junior High School. I asked the students to celebrate National Health Day, May 1, by giving me a May basket filled with health flowers. The health flowers were to be O.K. slips from their dentist. Although these are annual flowers, the students can, by applying tooth paste with a toothbrush, preserve them and have as a result everlasting flowers—life-time teeth.

I promised the students that if they reached the 100 per cent goal by May 1, they might send a telegram to our own Mr. Herbert Hoover, then President of the National Child Health Association, at Washington, D. C. May 1, a huge May basket was seen in the main corridor filled with health flowers—an O. K. slip from every child in the school. Thus, in the year 1926, the second year of our campaign, we arrived at the 100 per cent goal in exactly eight months, a gain of a month and one-half on the year before. We sent Mr. Hoover a telegram, and he wired the following reply:

Your wire May first received. This is a real, definite, practical accomplishment. It is better than a thousand resolutions and the best report we have had from any quarter. We may have a lot of trouble solving the problems of our generation, but if we can assure the sound health and moral fibre of the next generation in America, they will solve not only their own problems, but the ones we leave undone.

Is it any wonder that, from our community this second year, in 1926, came the healthiest girl in the state of Iowa—Alberta Hoppe—who tied for first honors in the National Health Contest in Chicago?

The third year, 1927, I asked the students to give me a Christmas gift and to be sure to have it ready for early mailing. At the end of seventy-three days, a most attractive package wrapped in tissue paper, tied with silver ribbon was delivered to me. The package contained O.K. slips from every child in the school. Once more, we arrived at that 100 per cent goal, with a gain of five months over the previous year. We wired Mr. and Mrs. Hoover a Christmas Greeting with teeth in it. We received the following letter in reply:

Accept the thanks of Mrs. Hoover and myself for the Christmas telegram "with teeth in it" which came from Woodrow Wilson Junior High students. The students are to be congratulated for the great record they have made, and you as their instructor deserve much credit. We hope that the next year will see another 100 per cent record. As President of the American Child Health Association, I hope to see all Americans develop good teeth, as good teeth mean good health, but I cannot help hoping that my native state of Iowa will take the lead. It will then be an inspiration to every other state in the Union.

Yours faithfully,

Herbert Hoover.

The fourth year, 1928, my request was for a health offering for Thanksgiving. So stepping on the gas, the children arrived at the goal with O.K. slips in exactly forty-five days, a gain of twenty-eight days this year. This year, we celebrated at the conclusion of our campaign by having a good teeth jubilee. The affair was held in the evening so that fathers as well as mothers might be present. The dentists of the city were our guests. The program presented by the children consisted of a number of lively songs and skits expressing appreciation to everyone who had been helpfully interested in our project. A most fitting close to our jubilee program was an illustrated lecture on teeth by G. H. Wandel, then director of dental hygiene in Iowa. Mr. Hoover wired the following message:

Doctor Crumbine and the staff of the American Child Health Association join me in congratulations to the Wilson students. It was fine teamwork that carried the pupils of the Woodrow Wilson Junior High School across the white sentinel goal for a perfect score. If I brag a little to my fellow-workers here that this was done in my native state, we can all join in assuring them that as fast as the native states of any or all of them tie the record, they will receive a warm welcome into your ranks.

Last June, before school closed for the summer, the Wilson students decided that August 1 was to be set aside as Good Teeth Day, so they painted that day red on their calendars at home. On that day, they were to call their family dentists (please note that we have *family* dentists now) for appointments in order to have their O.K. slips ready for the opening of school.

As a result, this fall the majority of O.K. slips came in the first day of school. At the end of seven days, all except six O.K. slips were in. At the end of nine days, all except four O.K. slips were on file. In two girls, there had to be several treatments before their teeth could be filled. These girls were newcomers in the community. Each of the newcomers had $45 worth of work to be done, so it was necessary to find dentists with big hearts, which is not a difficult task in Cedar Rapids, Iowa. One dentist said that he would consider this his contribution to benevolences and charged a nominal price. One dentist who wished to have a part in our campaign sent us a check, which we used to pay another dentist who had done more than his share for the Wilson girls.

This year, 1928-1929, the fifth year of our campaign, the Wilson students exceeded the speed limit and arrived at the 100 per cent goal in nineteen days, a further gain of twenty-six days. Mr. Hoover wrote us the following letter:

Thanks for letting me know that the state "where the tall corn grows" also has schools and teachers who keep their children alive to the value of health and cleanliness. My compliments to the pupils of Woodrow Wilson Junior High School. One hundred per cent in dental health five years in succession should enable the boys to build a winning ball team, and develop girl tennis champions. The American Child Health Association is proud of your record.

Yours faithfully,

Herbert Hoover.

The master key to any campaign is cooperation. "Cooperation is actual participation." In the city of Cedar Rapids, in the Woodrow Wilson community and in the Woodrow Wilson school, I have found this fine spirit of cooperation. There are no finer students and parents in the United States than those in the Wilson Community. Their dynamic spirit is most inspiring.

If we teachers wish to place a big brick in the children's wall of happiness, we should get back of this good teeth movement and put it across. Then we will have "Better children for our nation, and a better nation for our children."

ITINERANT HYGIENISTS

By GLADYS EYRICH,* Jackson, Miss.

THE most interesting development of the mouth hygiene program in Mississippi is the employment this year of two dental hygienists to do itinerant work. The object of this effort is to give communities which have sufficient local interest in the children's health the same service or better than that we are able to offer cities employing a full-time dental hygienist.

In April, 1928, a letter containing the following paragraphs was sent to all presidents of parent-teacher associations:

In formulating the mouth hygiene program for another year, there is the possibility of adding a dental hygienist to do field work on a cooperative basis if we could keep her busy.

This plan is as yet too tentative to give definite terms, but if a dozen communities could use a hygienist on the following basis or a similar one, I would feel justified in asking for such a worker.

Would your parent-teacher association, your community or your school board pay one hundred dollars for a hygienist's services for a month? This would be the entire cost. Materials will be furnished by the state. The hygienist will clean from ten to fifteen mouths daily besides instructing children and parents.

A card was enclosed for reply. Twenty-seven cards were returned, nine asking for a reservation of a month or less. As it seemed inadvisable to send a hygienist out for one week, two of these offers were omitted in making the final schedule, which covered twenty-two weeks. A hygienist was employed and came to Mississippi in June. After passing the state examination, she went to the Health Training Station in Indianola, Miss., for five weeks, where she was paid $3 a day while in training. The regular salary of $135 a month started the first day of August. During that month, she spent one week at the Congress of 4-H Club Boys and Girls, giving instruction and cleaning the teeth of the leaders. The rest of the month was spent at the state sanatorium for tuberculous cases, where it was thought the hygienist would probably spend some time during the year if the program was not entirely filled for the ten months for which she was employed.

Later on, so many additional demands came in for hygienists that a second girl was employed, the middle of October. The two workers have been busy every week, and all the time is taken until the first day of June. It is an interesting fact that not one community has fallen down on the agreement; two have secured additional time for the spring, and two had to be turned down because the time was full. The checks come in promptly and the expense has been less than was anticipated.

Aside from the equipment and materials, which are the same as that for other school hygienists, varying according to the individual operator, the traveling expense has been a small item, since the hygienists move only once a month and the itineraries have been governed by geographic location. When the salaries of these girls are raised next year, the

*Supervisor of the Division of Mouth Hygiene, Mississippi State Board of Health.

state will of course, spend more, since we do not plan to ask the communities for a larger amount than $100 dollars.

The programs of the hygienists have varied according to whether they were working in one community or a county. There must be some question in the minds of all who are acquainted with the work as to the advisability of a county-wide program just one month in duration. The hygienist may do a splendid piece of work, but when each school sees her perhaps once only, the result may be negligible. Nevertheless, when a board of supervisors votes $100 for this work, there is the desire on the part of this department to inform the community along the line of their own dental needs so that additional service may be demanded. At this writing, three months has been spent in three county-wide programs and the rest of the time of both hygienists in one town at a time.

Even in towns, the program differs according to the local demands. In one instance, the community wished every one of the 293 pupils enrolled to go home with a clean mouth, so the hygienist sacrificed her educational program and her own ideas to some extent and cleaned the teeth of every one. That school straightaway asked for another month in the spring, at which time it is hoped that the worker may proceed with more emphasis on the educational phase.

The school which uses a dental hygienist a month in the fall and again a month in the spring gets a more complete service than a town of nine grammar schools in each one of which the hygienist can spend less than a month.

During January, the two hygienists, one in a county program, one in a small town, sent in the following reports:

Scott County: Examined 1912 pupils in 28 schools; made 35 talks to: 23 schoolrooms, 8 chapel periods, 3 women's clubs, 1 civic club; cleaned 86 mouths of 4-H Club girls.

Only 4-H Club girls were given the opportunity of having teeth cleaned because of the limited amount of time. This was done in the office of the home demonstration agent, who drove the hygienist from school to school. One day, there was a surplus of thirteen patients, so one of the dentists came to the rescue and cleaned their teeth. The schools visited the first two weeks of January were very poor in attendance owing to the influenza epidemic. Some time was lost in traveling during the last two weeks of the month because of the condition of the roads, muddy and sleet from the heavy rains.

Report from Friars Point, a delta town of about 1,000 population: The first day was spent in acquainting the children with the work, and in making classroom talks. Prophylaxis was started the second day and was given to all the children present in the grammar school and to all those in the high school who had not visited the dentist within the month. There were 119 cases in all. The high school of thirty pupils reached 100 per cent in corrections. All the grades used the toothbrush charts daily. The superintendent suggested that the hygienist visit each room daily to make the check. This proved a decided stimulus to the children in making a perfect record.

For health work, the third grade made a sand table illustrating the value of diet and exercise. The fifth and sixth grades made some very interesting good teeth posters with reference to diet and cleanliness. A group from the third gave a play, "Johnnie's Dream," for a chapel period and before the parent-teacher association. Sixty children bought toothbrushes. There were four toothbrush drills given to all in the grammar school.

Where the itinerant hygienists have been employed, the attitude and comments of dentists, superintendents and parent-teacher associations have been most gratifying. We have been fortunate in securing two hygienists who are not only very attractive in personality but also are untiring and cheerful workers under all circumstances. When this combination can be found, the hygienist sells the work as she goes along, and the success of the venture is assured.

CARE OF THE BABY TEETH*

By R. C. WILLETT, D.M.D., Peoria, Ill.

IT must be clear to everyone that, in the time allotted for the broadcasting of this information pertaining to the care of baby teeth, I shall be able to present only the outstanding facts, but it is my earnest hope that further knowledge of this all-important subject will be sought elsewhere by parents and others on whose vigilant observation the welfare of the young child is dependent.

Before entering into definite advice in regard to methods and means for the care and protection of baby teeth, it is necessary to explain the important functioning of these teeth, their relation to growth and development of all parts of the head and the reflection of this process of head growth in the general growth and welfare of the child.

During infancy, all parts of the head grow rapidly, and in the case of the normal child, many parts have reached adult dimensions by the time the child is 7 years of age. During this most rapid growth period of the child's life, the baby, or deciduous, teeth erupt. In addition to the baby teeth, the first permanent molars are usually found to be fully erupted within this period of time, and possibly the lower baby central incisor teeth have been shed and the permanent ones have taken their place.

Too much emphasis cannot be employed in stating the fact that it is during this all-important period of infancy and early childhood that the teeth should receive the most thorough and painstaking care. Their full and unimpaired use is a prime aid to that rapid growth of the head, any interruption of which has a serious and permanent effect on the general development of the child.

Why?

1. Because the unimpaired use of sound baby teeth guarantees a better preparation, and therefore a better assimilation, of food for nutrition. The child, in proportion to its weight, must eat and assimilate about three times as much food as an adult.

2. Because, through the unimpaired use of baby teeth, the muscles of mastication are developed evenly, and the normal growth of the jaws and all associated parts of the head is directly promoted.

3. Because this stimulated growth of the jaws, through the unimpaired use of the baby teeth, is favorably reflected in the size of important air passages leading from the nose and throat, and these passages serve directly and indirectly in the proper aeration and oxygenation of the blood.

4. Because, if the baby teeth are in full and unimpaired use, the eruption of the permanent teeth will occur in more regular and correct position.

5. Because unimpaired baby teeth are a mental and physical comfort to the child, and promote his happiness and general good disposition.

When should the care of baby teeth begin, and when should the first dental

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inspection be given? This question is frequently asked by anxious parents, and to it various replies are made, but there is only one true answer, which is that as soon as the first tooth erupts far enough to be detected, the enamel surface of that tooth should be carefully examined for structural defects, and each succeeding tooth examined when it erupts. Defects in the first erupting teeth are not of such frequent occurrence as in the permanent ones, but you cannot afford to take the risk of an imperfection in the enamel of a baby tooth; if found, it should receive prompt and skilful attention, for such structural defects are prime indications of an early deficiency in nutrition, warranting not only local but also general attention to the child's physical condition. It is not uncommon to find large cavities of decay in the baby teeth before they have all erupted, and even at as early an age as 2 years.

The advice is frequently given that you are not to be concerned about the baby teeth until your child is about 3 years old, but to follow such advice is very dangerous. Parents, your responsibility for the care and the preservation of the baby teeth begins with the eruption of the first one of them.

While decay and cavities may attack any surface of a baby tooth, the surfaces most susceptible to decay are those between any teeth in close contact with each other; for decomposing substances lodge there, remain, and start tooth disintegration.

Parents should understand that the filling of cavities in baby teeth is a matter of vital importance; that such fillings should be placed for service, and should fully restore the natural form of the tooth, because any variation from its normal form will produce an effect that will be unfavorably reflected in many ways. For this reason, the filling of baby teeth demands of the dentist the same painstaking care that he gives to the making of fillings for permanent ones—yes, even more care, for the healthful condition and unimpaired use of these first teeth is essential in so many ways to the promotion of that rapid growth that occurs during the period of a child's life from infancy to its seventh year.

Of course, these teeth serve the child beyond that time, but possibly they are then of less importance to his physical growth and general health.

As parents, you probably have been told by well-meaning but uninformed persons, "It is only a baby tooth, let it go, it will soon come out, and will be replaced by another." This is the most unwholesome counsel that could be given or followed, unless the time has actually arrived for the normal removal of the tooth.

Owing to neglected and extensive decay or accidents, teeth are sometimes lost at too early an age. If this occurs, it is your duty to seek the services of a competent dentist or dental specialist at once for the making and placing of a suitable mechanical device that will be, as nearly as possible, a substitute for the prematurely lost baby tooth or teeth, and thus prevent interruption of normal head growth and proper arch formation.

HOME CARE OF THE TEETH

Cleansing of the teeth should begin with the appearance of the first tooth. At first, absorbent cotton, wound around the finger and dipped in a solution of boric acid, may be used. Later, a soft brush should take its place, this in turn to be replaced by a stiffer brush when all of the baby teeth are through the gums. The mother or the nurse should attend to this cleansing of the teeth until the

child is old enough to be taught to use the brush personally. The correct use of the toothbrush is a very important thing, for it is in the out of the way nooks and corners that food lodges, and the best method of removing it is by a rolling motion of the brush.

CARE OF THE TOOTHBRUSH

The mouth is never sterile, nor can it be made so, but it is possible to use such care that infections will not be carried into the mouth from outside sources. The toothbrush should be thoroughly washed and cleaned after each use of it and, above all, should not be permitted to come in contact with one belonging to another person. The custom of using a rack on which to hang the toothbrushes of the family is an unsanitary practice that has been responsible for the spreading of much mouth and throat infection.

MOUTH CLEANSING AGENTS

The use of a tooth paste or tooth powder is desirable, but there is no particular reason for the selection of any one make except that the one selected should not be gritty. Ordinary lime water is excellent for the cleaning of the teeth and rinsing of the mouth after the thorough use of the brush.

It is very important that brushing of the teeth should be done regularly (after each meal and particularly at bedtime). Remember that during any illness of the child, the teeth should be cleaned with special care, and at regular intervals daily. At such times, the bodily resistance is lowered, the secretions of the mouth are in a more or less unhealthy condition, and decay of the teeth is more likely to take place.

Our last plea in this message to parents and nurses is: Take the utmost care of the baby teeth, and cooperate with the dentist in his efforts to give the child his unrestricted service.

DENTISTRY AS A CIVIC OBLIGATION*

By P. G. PUTERBAUGH, D.D.S., Chicago, Ill.

PEOPLE of the present day have learned that the teeth must be properly cared for if they are to enjoy good health. Many people who accept this as a general principle do not fully realize the serious consequences which may attend neglect to care for the mouth. Proper care of the teeth is one of the most important items of personal hygiene.

If the teeth are allowed to decay, food cannot be chewed, digestion is impaired and the body is poorly nourished. One of the frequent causes of indigestion is found in decayed teeth.

Examinations of school children disclose the fact that in nearly every case of mental backwardness, there is also some physical defect of the eyes, ears or teeth. The surprising thing is that, among children who are behind in their school work, the condition of bad teeth is found more often than poor eyesight or poor hearing. When you consider the close relation of the teeth to digestion,

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and therefore to health and vigor, you can understand why this is true. The presence of decayed or infected teeth is the underlying cause of much of the illness in both adults and children. It is said that 80 per cent of all children's diseases arise in the mouth, nose or throat; and that 90 per cent of all deaths occur as the result of diseases that arise in this area. I dare say that everyone who has children would rather see them strong and healthy, with an ordinary education, than to see them as mental prodigies but with weakened, diseased bodies, unable to play or find enjoyment in life. The time has passed when the entire education of the child is devoted to mental development, while his physical welfare is neglected.

In Chicago, the cost of educating a child in the grammar grades in our public schools is $81 a year; and in our high schools, it is $120 a year. Every time a child is retarded and has to repeat a year, it costs the community just that sum to carry the repeater through the classes in which he has failed. The general average of retardations in the schools of the United States is almost 40 per cent; which means that 40 per cent of the cost of public education is expended in carrying retarded pupils through grades in which they should have completed the work the first time. Last year, it cost the City of Chicago $3,240,000 to teach its retarded children.

Much of the stupidity observed in school children is due to poor health; and much of the poor health is directly traceable to bad teeth. If the child misses from three to five weeks of school or is forced through sickness to attend irregularly, he will probably miss his grade that year; and it costs just as much to teach the child the same thing the second time as it did the first.

A most important saving is to the child's self-respect. Failure psychologically suggests to the child that he is a blockhead — that he cannot learn and make the grade as the other children can; and self-pity or discouragement will probably be the handicap with which he approaches subsequent tasks. Certainly, the extra expense involved in carrying out a dental health program could never equal this saving.

In Atlanta, Ga., in 1924, 32 per cent of the children failed to pass their respective grades. During the following year, a dental program was introduced, and in the final test at the close of the year's work, only 8 per cent failed to pass. Before they introduced this system of health education, their average attendance was 83 per cent; after its introduction, the attendance moved up to 97 per cent. Similar reports have been obtained from other cities. The results in Bridgeport, Conn., and Cleveland, Ohio, are other outstanding examples of the value of dental health education in the public schools. Tabulated results of the examination of the mouths of school children disclose defective teeth as follows: New York City, 82 per cent; Cleveland, 92 per cent; Chicago, 96 per cent.

And the children are only a small part of the community. Employers know how much time is lost in sick leave and how much more is lost through employes who come to work but are too sick to do more than half an ordinary day's work. Rheumatism, headache and many serious diseases can be directly traced to mouth infection. Last year, the annual loss in industry in the United States due to illness which was largely preventable ran up into many millions of dollars.

A well organized plan of dental health education will prevent much physical suffering, and few of us are willing to

condemn others to suffering if a remedy to prevent it lies conveniently at hand.

In an effort to apply a remedy to this appalling state of affairs, within the last few years the pendulum of health service has swung from repair to prevention. There is really no justification for the present-day conditions which exist in the mouths of people of America. This condition should never have developed and would not have developed had people known of means to prevent it. Dentists are now emphasizing an educational program that embodies as its main feature prevention rather than cure of dental diseases. Filling cavities alone can never bring about the millennium of perfect teeth, for many people never go to a dentist until their teeth are too badly decayed to be saved. It has been estimated that although there are 60,000 dentists in the United States, if an attempt were made by them to fill all the cavities now in existence, it would take 112 years to accomplish the purpose provided no new cavities formed during that time. It is thus impossible to attack the problem from the angle of repair only.

Tooth decay is largely a preventable disease. The routine practice of correct brushing of the teeth, together with a well balanced diet with the proper selection of foods to meet the individual's needs, coupled with modern methods of living, will overcome, in great measure, the faulty conditions existing in the mouths of our people today.

Educators have learned that it is impossible to spread the gospel of proper living through lectures or other means of disseminating information to our adult population. It must be taught to the children and made a part of their daily-life habits. Sutton of Atlanta says: "I am of the opinion that if we take care of the teeth of boys and girls from the time they enter the first grade until they are 18 years of age and instil good dental habits, it will add five years to the life of every one of them." Five years for each boy and girl is worth saving; and this does not take into account the comfort and happiness added to all the other years.

Mouth examinations are necessary. The cost of such service is relatively small, as it has been shown to be less than 3 per cent of the cost of education as a whole. When it is considered how much more efficient this will make the expenditure of the other 97 per cent, you will appreciate that its original cost is negligible.

The first step, then, is to secure the establishment of dental health instruction in the public schools. Instruction can be given in part by the regular teacher and in part by the school nurse or physical education teacher.

Chicago spent three and a quarter millions of dollars last year to reeducate students who failed to be promoted; yet the City Council has appropriated only one-sixtieth of that amount this year for the purpose of dental health service. This is entirely inadequate; and for the good of the children of your community, you should use your influence to have the appropriation raised at least to $250,000 a year in the near future.

HOME CARE OF THE CHILD MOUTH*

By G. H. WANDEL,† D.D.S., Chicago, Ill.

GOOD morning, Mothers. I suppose all the Tommys, Marys, Bobbys and Ruths are outdoors playing by now, and you have just a few minutes to relax and learn something about children's teeth. If I could talk to you right here in this room, I'm sure I could make you understand better the things that I am going to tell you.

Talking about all the Tommys, Marys, Bobbys and Ruths, who are now outside playing, did they all have their teeth brushed before they went out to play? That's fine. I'm glad they did. Yes, I know you have been so busy all morning, Mrs. Brown, that you haven't had a chance to attend to Tommy's teeth. But you'll take a little time after while to do that, won't you? You know, all youngsters should have their teeth kept clean from the time they get their first tooth. If you can, it would be well to clean them at least twice a day, once in the morning and once at night before the child goes to bed. Now, if you forget any of these brushings, be sure you don't forget the night brushing. That is the most important of all.

In beginning for the first time to brush a child's teeth, there are several things to remember. Be sure not to do anything that will cause the child any feeling of discomfort. It would be well to do a rather careless job of it the first few times, gradually using more care as the child becomes accustomed to having his teeth brushed. The night brushing should not be delayed until the very last minute, because the child is usually tired and easily irritated, and the brushing would not be a pleasant task for either mother or child. Try to do these brushings under as pleasant conditions as possible. That reminds me, too: To be sure that you do not start off wrong, I would suggest that you use nothing on the brush in the way of a tooth paste or mouth wash until the child has become thoroughly accustomed to having his teeth brushed. Many children have become fighters of the toothbrush because parents have started the brushing process by using something on the brush which the child did not like. You might think that a certain paste tastes good to you, but it might not appeal to the child. Of course, you may rinse the brush now and then with fresh water. After a month or two of brushing with the bare brush, you might then add a little limewater or some mildly flavored, good tasting paste or powder to the brush. I would do this carefully, however, and use only a very small amount the first few times. If the child dislikes it, stop the use of it at once, and wait a few days, and then try something else. If the child seems to like what you have used on the brush, gradually increase the amount used until you are using sufficient to do what you would call a good job of brushing. In this connection, it would be well to remember

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†Supervisor, Bureau of Dental Health Education, American Dental Association.

that, after all, the thoroughness of the brushing is what accomplishes results. The paste or powder serves to make the operation a little more pleasant and effective.

I can tell from the look on your face, Mrs. Smith, that you are anxious to ask me a question? You want to know something about the toothbrush? Well, first of all, every child should have his own toothbrush. A good way to keep them from becoming mixed is to have a different colored brush for each person. The brush should be a child's size brush; small, in other words. The bristles should be reasonably stiff, and tufted, with spaces between each tuft of bristles. Two or three rows of bristles, running the long way of the brush, are sufficient. If you can afford it, it is well to have two brushes, permitting the bristles of the one to dry out and stiffen up while you are using the other. A stiff bristle does a much better job than does a soft, easily bent bristle; and you know, if a brush is used several times a day, day after day, without an opportunity to dry out, the bristles will become quite soft and ineffective.

What was it that you were going to ask, Mrs. Brown? You want to know something about the care of the brush? That's a good question. There are several things to remember. About once a week, it would be well to wash the brush thoroughly with soap and water. Rinse it carefully under a strong stream of hot, running water; shake the water out of the brush and hang it up in the sun to dry. Each time the brush is used, it should be well rinsed under a strong stream of running water, the water shaken out, and the brush hung up to dry. In hanging it up, the head of the brush should be uppermost and the handle down. Brushes should not be hung so close together that they are in contact with each other. Brushes hung too close together may spread disease from one member of the family to another.

There's a good question: Mrs Smith wants to know how to go about brushing Bobby's teeth. Many parents have difficulty in controlling their child while they are attempting to brush his teeth. Now, Mrs. Smith, I can't see Bobby, so I don't know how tall he is. But if he is still quite short, I would sit down on the edge of a chair or stool, and have Bobby stand in front of me, resting the back of his head against me. If he is too tall for that position, I would stand up and have him stand in front of me, resting the back of his head against me, with his head tilted slightly backward. We will brush the outer surfaces of the teeth first, starting on the lower front teeth, and after they are brushed, we will brush the same surfaces of the back teeth. We will then follow the same plan with the upper teeth. This is all done with Bobby's mouth open just a little bit. In using the brush, we use a sort of a sweeping motion, sweeping or twisting from the gum toward the biting surface of the teeth. On the upper teeth, this motion would be downward from the gum; on the lower teeth, it would be upward from the gum. Now, we want to clean the inner or tongue-side surface of the teeth. We will have Bobby open his mouth fairly wide, and we will brush the inner surfaces of his lower back teeth. When they are clean, we will have Bobby tilt his head backward a little more, and we will then brush the inner surfaces of his upper back teeth. The brushing of this part of these upper and lower back teeth is done with the same motion as was used on the outer surfaces, namely, from the gum toward the biting surface of the teeth. Now, we are ready to brush the

inner surface of the upper and lower front teeth. This is done by inserting the brush into the mouth just the same as you would a fork when eating. Press the bristles lightly against the inner surface of the lower front teeth and pull the brush outward, pulling the bristles from the gum across the tooth toward its biting edge, much as you would pull a lawn-rake. Repeat this until the inner surfaces of all the lower front teeth are clean. Now, do the same thing with the upper front teeth. At last, we are ready to brush the biting or grinding surfaces of the upper and lower back teeth. We must not forget these surfaces, either, because more decay gets started on these biting surfaces than upon any others. Let's give Bobby's neck a little rest by brushing the biting surfaces of his lower teeth. Place the ends of the bristles right down upon these surfaces, jiggling or shimmying the brush a little as we press it upon the teeth. This forces the bristles into the depressions of the tooth and loosens food materials which might have lodged there. Now that these food particles are loose, we will carry them off the teeth by pulling the brush across the biting surfaces several times in much the same manner as we brushed the inner surfaces of the front teeth. After we have finished the lower back teeth, we can have Bobby tilt his head backward again, and in the same manner, brush the biting surfaces of the upper back teeth. At last, our job is finished. It appears to be quite a chore, but it's not bad at all. Be sure and permit Bobby to spit once in a while, Mrs. Smith, so that he won't choke on his saliva. Also, give him a glass of lukewarm water with which to rinse his mouth, after the brushing has been finished.

Just a few words of explanation: I had you stand behind Bobby to do the brushing, because it gives you complete control of him and a better view of his teeth. In such a position, it will be difficult for the child to jerk or pull away from you. I had you brush the outer surfaces of the teeth first, because they are the easiest of access and will be the least objectionable of all the surfaces to have brushed. For the first few times, it might be well to brush only the outside surfaces. After the child becomes accustomed to that, gradually add to it. You will know just how far you can safely go with your children, and each child will have to be governed accordingly. I had you brush the inner surfaces of the lower back teeth next, because, to the child, these surfaces are probably the most objectionable to have brushed, and I believe that it is best done at about the middle of the whole task. We followed this with the brushing of the inner surfaces of the upper and lower front teeth, and finished with the easiest of all, the brushing of the biting surfaces of the back teeth. Doesn't it all sound reasonable and practical?

ST. LOUIS CARES FOR ITS CHILDREN'S TEETH

Ten new dental clinics for the children of St. Louis have been provided for by the board of aldermen, which has appropriated $35,000 for the purpose. A dentist will be employed at each clinic for four hours a day. In addition, a supervisor's office and an extracting clinic will be opened in the municipal courts building. The Red Cross is cooperating by donating the equipment for eight of the clinics.—*Children's Bureau, U. S. Department of Labor.*

HOW MANY SCHOOL CHILDREN HAVE HEART DISEASE?

The prevalence of heart disease among the school children of this country has had little investigation. A recent examination of approximately 120,000 Boston children of school age showed that 785 had organic heart disease. Routine examination of school children in New York City indicates that

seven in every 1,000 have diseased hearts—the same rate as was discovered in 1924 among children in the elementary schools of England and Wales. The Heart Committee of the New York Tuberculosis and Health Association, which recently published these figures, calls attention to the importance for such children of education beyond the elementary grades, so that they may be able to find work and amusement which will not unduly strain the heart.—*Children's Bureau, U. S. Department of Labor.*

PREVENTIVE DENTISTRY

At the recent First District of New York dental meeting, great emphasis was laid on several points which every one who has the supervision of children should know about and act upon.

In the first place dentistry should have an important part in every child health program.

Of all diseases of childhood, dental caries, (decay) is the most prevalent. Moreover, unless a child gets a warning toothache dental caries may go undetected for a long time and all the while it may be a source of infection and of lowered health status.

The effects of dental caries are often serious. You may fail to realize that your child's teeth are carious but observe troublesome symptoms in other parts of his body. There is frequently a connection. Caries in the teeth sometimes affects other parts of the body and impairs their efficiency. In neglected cases the harm done cannot always be undone. It may result in a permanent impairment.

Therefore, dental caries should be detected as early as possible by the dentist. If this is to be furthered, children must visit the dentist at regular intervals. These visits are fundamental in a health program.

The dentists have a grave responsibility resting upon them. They must not only put defective teeth in good order; but they must carry on an educational service in their offices. Education is the best preventive measure and should be as much a part of the dentist's daily work as is his reparative procedure within the mouths of his patients.—Leroy A. Wilkes, M.D., Director, Division of Medical Service, American Child Health Association, in *American Child Health News,* January, 1929.

THE FIELD FOR CHILDREN'S DENTISTS

Preventive dentistry begins with the health education and care of the pregnant mother and includes the unborn infant. Dr. E. V. McCollum, professor of Chemical Hygiene in the School of Hygiene and Public Health, Johns Hopkins University, in referring to the nation-wide goal held before school children, of repair and cleanliness of teeth, has said that in this we are "trying to put an attractive superstructure upon a faulty foundation." It is not that we do not want repair and cleanliness. We do. But we want to go back to the underlying conditions that make the repair necessary and prevent those conditions. Good teeth, modern science tells us, are determined before a child is born. Good teeth, science further tells us, are one of the essentials of good health. . . . A preventive dental program is an integral part of the whole child health service which the country is developing.—Aida de Acosta Breckinridge, in *American Child Health News,* January, 1929.

SELF SELECTED DIETS OF NEWLY WEANED INFANTS

In speaking of recent experiments in permitting newly weaned infants to select their own diet,[1] Clara M. Davis says *(American Child Health News,* January, 1929):

"One of the most astonishing incidents was that connected with one rickety baby. Pure cod liver oil and cod liver oil incorporated in S. M. A. (a recently developed infant food) were served on his tray. He selected generous portions of the cod liver oil in both forms until the rickets was cured. As soon as rickets had healed (and this healing was ascertained by the regular scientific tests) the child ceased voluntarily to take cod liver oil in either form."

PROFESSOR SUTTON VISITS WISCONSIN

Willis A. Sutton, superintendent of the public schools of Atlanta, Ga., last fall made a three weeks' tour of Wisconsin, visiting Appleton, Kewaunee, Manitowoc, Green Bay, Neenah, Oshkosh, Beaver Dam, Juneau,

1. Davis, Clara M.: Self Selected Diet of a Newly Weaned Infant, J. A. D. A., 14:1119 (June) 1927; Self Selection of Diet by Newly Weaned Infants, Am. J. Dis. Child., 36:651 (Oct.) 1928.

West Bend, Madison, Tomahawk, Wausau, Stevens Point, Marshfield, Waupun, Reedsburg, Kenosha, Fort Atkinson, Oconomowoc, Waukesha, Milwaukee and Watertown, and addressing audiences of dentists, physicians, social workers and teachers on the subject of oral hygiene. In forty addresses, he spoke to more than 18,000 people. J. F. Mortell, of Oshkosh, was instrumental in getting Professor Sutton to come to Wisconsin.

CURRENT LITERATURE

EXTRACTS AND ABSTRACTS

Ultraviolet Rays in Treatment of Dental Disease: The author (H. G. Frankel, in *Arch. Phys. Ther. X-Rad.,* January, 1929) lists the following conditions as subject to the beneficial influence of the ultraviolet ray: dental caries, all infections of teeth and gums, including gingivitis, ulcers of all types, cellulitis, periostitis, Vincent's infection, acute alveolar abscess, all inflammations of the peridental membrane, neuralgia, pyorrhea, postoperative pain, postoperative infection orthodontia and faulty development of body tissue due to lack of calcium. The last mentioned may be corrected by "tonic radiations." The ultraviolet ray has been found also to act as a germicide. In gingivitis, the teeth are scaled and an erythema dose of the ultraviolet ray is then given, at two inches, for one-half minute. Periostitis is treated in the same manner, except that, in localized cases, a quartz rod is used either in contact or under compression. Care is taken not to blister the tissue. In Vincent's infection, the entire mouth is irradiated, including the tonsils and posterior wall of the pharynx, to insure complete eradication of the infection. In the author's experience, this treatment has proved virtually a specific for this condition, from two to twenty or more exposures being necessary. Use of the ultraviolet ray is advocated in all cases of pyorrhea except those in which there are extensive inroads in the alveolar process and peridental membrane. It is the author's theory that the presence of pyorrhea indicates a general lowered resistance and that the calcium and phosphorus metabolism can be improved by body irradiation. In addition, after the teeth have been scaled and polished, the quartz rod should be applied directly at six points, not more than five teeth being treated at one time. In the technic advocated by Sampson, a two or three minute application is given at each point, even to the point of blistering. The author advocates the use of graduated exposure time, beginning at one-half minute and increasing the time one-half minute at each treatment. Thus resistance is gradually built up in the mucous membrane and massive doses can be given without discomfort to the patient. In alveolar abscess, the ultraviolet ray is, in the author's experience, of greater value than any drug. He uses it in palliation after removing the cause of the condition by drainage and sterilization. The quartz rod is applied for from one-half to one minute. One or two treatments serve to reduce the swelling and the treatments are continued for several weeks after the canals have been filled. In orthodontia, the treatment is preventive, general irradiation of the body being advocated to improve metabolism. The author believes that the ultraviolet ray is as valuable in dentistry as in medicine.

Prevention of Rickets by Means of Ultraviolet Irradiation: Three hundred and eighty-six babies were studied to determine whether ultraviolet irradiation was a practicable method to use for the prevention of rickets. Clinical and roentgenographic examinations were made up to and including 8 months of age. When twins, premature and syphilitic infants and babies lost from observation were eliminated, 237 cases remained for analysis. These were divided into four groups in order to eliminate the complicating factor of cod liver oil. The infants in the group receiving irradiation and no cod liver oil showed 17 per cent of rickets, as compared with 56 per cent of the control group who received no irradiation and no cod liver oil. No baby receiving more than sixty-five minutes' total treatment up to 8

months of age developed rickets. Most of those developing rickets had intervals of two or more months without treatment. It was found that eleven minutes' total irradiation a month without any other antirachitic measures prevented rickets in 98 per cent of the babies studied up to 8 months of age. A smaller amount than this was found to be efficacious in many cases, particularly when the treatments were given regularly and the lapses between treatments were not too long. —Selkirk, Greenbaum and Mitchell in *J. A. M. A.*, Dec. 29, 1928.

Agranulocytic Angina: Although agranulocytic angina is not a common condition, three cases were seen by the author (I. M. Trace, in *Illinois M. J.*, January, 1929) within less than three months. The three cases had in common a severe gangrenous angina, a marked neutrophilic leukopenia and a fatal termination. Two of the cases were in women, aged 32 and 42, the other in a man, aged 25. All treatment proved futile. Diphtheria, Vincent's infection and streptococcic sore throat were diagnosed, and the true nature of the condition was not recognized until the blood was examined. In each case, the onset was sudden and severe. The author concludes that in a gangrenous lesion of any mucous membrane, where diphtheria and Vincent's infection are ruled out, the possibility of agranulocytic angina should be borne in mind and a blood examination made.

Atypical Vincent's Angina: A child had swelling of the jaw for two weeks, experiencing pain and inability to open the mouth; the pain gradually migrated from the right to the left side. The patient was admitted to the hospital on October 11. At that time, there was marked sloughing of the gums, with loss of the lower incisors. There was much green purulent material about the mouth and what appeared to be an alveolar abscess at the base of the lower molars. A hard, red, indurated mass then developed in both jaws. This looked like a beginning noma, and had the odor of gangrene. The treatment consisted of hourly lavage with peroxide. The culture gave a negative reaction at first; finally, fusiform bacilli with spirochetes or spirillae were found after anaerobic culture. On admission to the hospital, the patient had a temperature of 101 F.; the red cells numbered 4,900,000, the white cells 9,000; the hemoglobin amounted to 90 per cent. Lavage with peroxide cleared up the condition quickly, although the gum remained deeply indurated. The swelling of the jaw gradually subsided. The diagnosis considered was that of an osteomyelitis of the jaw, and atypical Vincent's angina based on a primary alveolar abscess. The ordinary internal treatment with potassim chlorate was employed, and the child also received sulpharsphenamine, but the lavage with peroxide was apparently the most effective measure in this case.—C. K. Stulik, in *Am. J. Dis. Child.*, January 1929.

Cancer of Tongue and Floor of Mouth: Dorrance and McShane (*Ann. Surg.*, December, 1928) present an analysis of 164 cases of carcinoma of the tongue and floor of the mouth treated by radiation therapy. It is very striking that 53 per cent of the total number of patients and 75 per cent of those in whom the duration could be determined from the history lived less than one and one-half years irrespective of the type of treatment they received. It would seem that the natural history of cancer of the tongue and floor of the mouth is one of short duration. The Wassermann test was done in 112 cases. It was negative in seventy-four and positive in twenty-eight. In the patients with concomitant syphilis, the disease had a shorter course and seemed more virulent than in those with a negative Wassermann reaction, when judged by the history of the duration of the disease. Of the 164 patients, twenty, or 12 per cent, were admitted in a dying condition and lived from one day to three weeks. Another group of eighty-five, or 51 per cent, presented marked cachexia, extensive primary involvement and widespread neck metastasis when they first came under care. They received moderate mild irradiation as palliative treatment and died in from one to six month. There were twenty-seven, or 16.4 per cent, who lived from six months to one year. Twenty-five presented neck metastases on admission. In regard to the operative procedures done on these patients, seven were treated by electro-coagulation; four had a Janeway gastrostomy; fourteen had alcoholic injection or resection of the fifth nerve and the superficial cervicals, and ten had unilateral bilateral ligation of the external carotids. The greatest help given these patients in the advanced stage of cancer was relief from their pain. The authors conclude that no one method is the ideal way to treat cancer of the tongue and floor of the mouth. They ad-

vocate in those patients who are good risks, and whose disease has not spread so that they are in the hopeless class, radium packs to the neck, gold tube implantation into the lesion in sufficient dosage either to destroy the lesion entirely or to cause a sharp radium reaction, and, at the end of from ten to fourteen days, electrocoagulation of the lesion with possibly a preceding bilateral ligation of the external carotid, depending on the extent of the lesion. In patients who are poor surgical risks and yet have early or only moderately advanced cancer, the treatment advocated is given, but the lesions are not always coagulated. Sometimes in these patients, after the gold tubes have been inserted, the lesions have so far regressed that coagulation is not indicated, or they have entirely disappeared. Advanced cases either are not treated at all, or else the metastatic modes are irradiated vigorously and gold tubes are implanted into them and into the primary lesion. No patients with metastatic nodes in the neck have been cured by irradiation.—Abstr. *J. A. M. A.*, Jan. 26, 1929.

Necrosis of the Mandible: A case of necrosis of the mandible in a man, aged 42, is reported by H. P. Bayliss (*Dent. Surgeon,* Jan. 5, 1929). The patient had been treated for twenty years for syphilis. In November, 1926, while taking intermuscular mercurial injections and neo-arspehnamin intravenously, he developed diarrhea and gastric symptoms. The lower six front teeth were extracted under nitrous oxid anesthesia; which left the jaws edentulous. Extensive ulceration of the mouth followed, and the patient was given fairly large doses of potassium iodid, the treatment for syphilis being discontinued. The surface of the bone of the anterior portion of the mandible then became denuded of soft tissues and sensation disappeared from the lower lip. In March, when the patient came to the Dental Department of Guy's Hospital, almost the entire depth of the mandible was exposed to the extent of the sockets of the six front teeth. A mouth wash of liquor potassae and phenol was used and the exposed bone was kept clean by swabbing with hydrogen peroxid. Six months after the extraction of the teeth, the sequestrum was sufficiently free to be lifted out, and six weeks later, a satisfactory lower denture was fitted. Sensation subsequently returned to the lower lip.

Operation for Unilateral Harelip: Hartel (*Beitr. z. klin. Chir.,* Oct. 15, 1928) points out that instead of regarding the lip as an indivisible whole, each component part should be considered separately in attempting a repair of a harelip. He undermines the skin, freeing it from the muscle, and similarly undermines the muscle layer so as to free it from the labial mucosa. Then each layer of tissue is approximated end to end and sutured with catgut, care being exercised to avoid tension. The red margins of the lip are carefully sutured with fine silk. Tension sutures of strong silk should be inserted if called for. Bleeding is controlled by means of hot salt compresses or very fine ligatures. The operation is as applicable to very young children as to adults.—Abstr. *J. A. M. A.*, Jan. 26, 1929.

Idiosyncrasy to Procain (Novocain): The following curious case is described by M. Anbriot in *La Revue de Stomatologie.* The patient was a girl of twenty years whose tonsils were being removed under local anesthesia. The solution used was a one per cent solution of novocain, and only a few cubic centimeters were injected. The train of symptoms was as follows: clonic convulsions lasting only about twenty seconds, followed by profound cardiac depression of about half an hour's duration. From this attack, the patient recovered, but shortly afterwards she developed diffuse cellulitis of the neck which lasted for a week. Untoward symptoms following the injection of novocain are so rare, especially with a solution so weak as one per cent, that this case is especially striking. The author puts forward the suggestion that some abnormality of the endocrine apparatus was present. In this connection, it would be interesting to know whether the solution contained adrenalin, and if so, in what strength. —*Dent. Surgeon,* Jan. 19, 1929.

Injection of Alcohol for Neuralgia: W. H. Rushton (*Dent. Surgeon,* Jan. 5, 1929) reports the case of a clergyman, aged 69, who suffered from persistent and acute facial neuralgia. He was edentulous. Roentgenograms revealed nothing significant. Alcohol was injected into the left foramen ovale with complete success. About one year later, the patient returned with the complaint that his dentures no longer occluded. It was found that the lower teeth had shifted about one-half inch to the right. When the mouth was opened, the mandible descended to the left.

The denture was remade to adjust the bite. Recently, another adjustment had to be made. A note by Mr. Harris, who made the injection, is given: "In injecting the left foramen ovale, the motor root of the fifth nerve is always paralyzed together with the sensory fibres, so that besides weakness of the masseter and temporal muscles for the up-and-down bite, the external pterygoid is also paralyzed. Consequently, in opening the mouth, the lower jaw drops towards the left side, being pushed over by the sound external pterygoid of the other side. In closing the jaw to bite, the sound internal pterygoid and masseter and temporal will pull the mandible slightly too far across (to the right). Usually, the motor root recovers very considerably, even when the ganglion is injected, as its trophic cells lie further back in the pons, but in some cases the muscles do not recover, and then there is obvious wasting above and below the zygoma, which stands out prominently." The author adds: "It would be interesting to know whether, if the patient had not been edentulous, the same result would have occurred or whether the interlocking of the cusps of the opposing natural teeth would have been sufficient to maintain the normal bite."

Repair of Facial Defects: Aspinall (*J. Coll. Surgeons Australasia,* November, 1928) describes a method of quickly covering over a large area of the face. A flap is fashioned on the scalp, at least one-half larger than the area to be covered by it, with the hinge of the flap situated on the forehead at the base of the nose. The hinge is removed later. The flap is swung over the area to be covered and loosely but accurately stitched into position by interrupted horsehair sutures, a medium sized drainage tube being placed in the most dependent site. While the surgeon is suturing the flap into position, his assistant removes a flap of skin from the abdomen, of sufficient size to cover the denuded area of the skull. The abdominal flap is removed by means of elliptic incisions and all fat is removed from the flap during the process of dissection. The skin they removed is cut into small pieces and placed on the denuded area of the skull and firmly pressed home. The skin of the abdomen is rapidly coapted by means of sutures.—Abstr. *J. A. M. A.*, Jan. 26, 1929.

Burning Sensation in Tongue Caused by Hyperacidity: Chemical examination of the saliva in patients with a sensation of burning in the tongue yielded normal results. (J. Sellei, in *Deutsch. med. Wchnschr.*, Oct. 19, 1928.) The idea that the trouble might be caused by sharp teeth or the material used in dental work was entertained, but dismissed after investigation. On the other hand, most of the patients were found to have slight hyperacidity; anacidity was found only occasionally. Where the latter observation is made, pernicious anemia should be suspected. In all cases of burning in the tongue, the gastric juice and the blood should be examined. A search for tapeworm should also be made.—Abstr. *J. A. M. A.*, Dec. 29, 1928.

Bone Sarcoma: It is very evident from our experience that continual irritation or moderate force has a tendency toward the development, or at least activation, of the growth of bone tumors, but there is little, if any, evidence from which we can conclusively assume that such tumors are developed through one act of trauma in which the force is moderate or severe.—Philip Stephens, in *Am. J. Surg.*, October, 1928.

Can Neoplasms Be Controlled by Diet? The devices that have been tried both by experimentalists and by clinicians in the effort to control the growth of neoplasms in the body have been numerous and varied. The ineffective action of drugs has come to be an accepted fact. Surgical procedures do not invariably prove successful in eliminating malignant growths; nor are they expected to be, for there is always the possibility of metastatic growths. Reputed cures depending on the alleged bacterial origin of neoplasms have repeatedly been found valueless. The use of radium and the roentgen-rays has been successful as a palliative under certain conditions. With the rise of interest in nutrition as one of the fields in preventive medicine have come repeated efforts to control the growth of tumors by adjusting the factors in the diet. As various nutritive substances have been found to exert apparently specific influences on the growth of the organism as a whole, attempts have been made to control the development of malignant tumors by withholding such dietary factors from the animal affected. Thus, the host organism has been stunted by depriving it of certain essential amino-acids or one or more of the vitamins or certain lipoids in the hope that just as the neoplasm grows faster than the host so will it be more severely inhibited by adverse

conditions for development. The results of this type of study have been uniformly disappointing from the point of view of evolving a dietary cure. Nakahara and Somehawa have reinvestigated the alleged inhibiting effect of foods from fats and lipoids, using rats under carefully controlled dietary conditions. Comparing the development of both rapidly and slowly growing tumors in animals given fat-free foods with rations containing fat or lecithin or cholesterol, these investigators came to the conclusion that the almost total absence of dietary fats or lipoids does not retard the growth of a transplanted carcinoma or sarcoma in rats to a notable degree. These studies emphasize again the essential parasitic nature of such neoplasms. The tissue cells of the host show the effect of alterations in the ration before those of the tumor do. One may, perhaps, extend this line of reasoning to any vital organ in the body. There are instances in which the entire reserves of the somatic tissues are called on to preserve or to restore an indispensable organ. It has been shown that an experimentally produced hepatic necrosis can be fully repaired in an animal whose ration does not contain enough of the amino-acid lysine for growth in body weight and that this reparative process is as rapid as that occurring in an animal receiving a complete diet. The organism can, apparently, shift its tissue-building resources under stress of circumstances. In the case of malignant tumors, however, the favored structure is one distinctly detrimental to the host.—*J. A. M. A.*, Oct. 27, 1928.

Foreign Literature

A History of Dentistry (von Fritz Lejeune, Fortschr. d. Zahnheilk., No. 12, 1928, page 1142): Little attention has been given by historians to the recording of early dental practices. About the sixteenth century, three Spaniards undertook the task of collecting evidences of early dentistry as practiced in pre-Columbian America. They have also furnished some evidence that dentistry was practiced in Africa very early. The work was confined largely to the treatment of toothache and the removal of offending members. Soldiers pried out the teeth with their spears. The practices of medicine, dentistry and cosmetics were very closely related with witchcraft. . . . Tooth mutilation was very extensively practiced by early races in their beauty culture. The types of tooth mutilation can be classed under three heads: 1. Notching and splitting. 2. Total removal of some of the anterior teeth. 3. Pointing and tapering. Historians can frequently distinguish nationalities by the particular types of tooth mutilation. Practices of tribes that have been widely scattered persist for many generations. Historians studying the development of culture find these facts of great significance. Emil Mueller, Chicago.

Legal Questions Pertaining to Dental Practice (Ludwig Ebermayer, Fortschr. d. Zahnheilk., No. 12, 1928, p. 1053): Strict maintenance of professional secrets is absolutely essential for the establishment of confidence. The law as well as professional ethics make it a duty for professional men to guard strictly the secrets incident to their work. This applies only to licensed practitioners and their employes and to medical students. Secrecy is not forced on unlicensed practitioners. Those of the public that patronize quacks must take their chances. The primary aim of the law to protect the interests of the individual. In cases in which the interests of the community are greater than those of the individual, as in the case of infectious diseases, the law makes it compulsory that the condition be reported. . . . There exists quite a traffic in bogus degrees in practically all countries. There are schools that issue degrees to be used in foreign countries not recognized at home. In consequence of industrial changes during recent years, the attitude toward the sale of practices has undergone considerable alteration. It used to be regarded strictly against all good form and ethical laws to sell professional practices. That attitude toward this procedure has changed, and it is now possible to sell one's equipment under urgent circumstances without trespassing the laws of ethics. . . . The law does not tolerate the collection of large fees from the wealthy to compensate the practitioner for losses incurred from the poorer patients. An interesting decision was rendered by the court at Berlin which permits cosmetic plastic surgeons to collect fees only in the event that the operation is successful. . . . Specialists and professors are permitted more latitude in the collection of fees than is granted the average practitioner. Emil Mueller, Chicago.

Anomalies of the Fetal Ectoderm (Dr. Zimmerman, Vierteljarsschr. f. Zahnheilk. 44:419, No. 3, 1928): During the first few

weeks of fetal life, disturbances of the ectoderm, such as atrophy or hypertrophy, may be responsible for anomalies in certain anatomic structures which have their origin in the outer layer of the embryo. Many patients from the Zahnärztliche Institut (Dental College) of the University of Königsberg are cited. These exhibit absence of finger and toe nails, often including also the absence of the entire terminal phalanges, alopecia, hypertrichosis (superabundance of the hair growth), keratosis of the hands and feet, elephantiasis of the gums and alveolar processes, and congenital absence of most of the deciduous and permanent teeth. The article is illustrated by many fine photographs, roentgenograms and photomicrographs, and the literature of the subject is also reviewed. Virchow is mentioned as having described the "Russian hairy men" the "hirsutes," who, although their bodies were covered with a thick growth of hair were nevertheless almost entirely devoid of teeth. Hyde, on the other hand, described cases with alopecia (absence of hair) that had also webbed fingers and toes and a deplorable absence of teeth. Apfelstädt saw a woman who had never developed a single tooth, deciduous or permanent. Her two daughters were a little less unfortunate, each having about one third of the normal complement of teeth. Lange tells of a mother normal in every way except that she was without eyelashes or eyebrows. Of her six children, four had irregularities in the development of hair, nails and teeth. Hart cites the case of a 13-year-old girl with general atrophy of the skin, alopecia and dystophy of the nails. Both her mother and maternal grandmother were likewise afflicted. Nasse saw hereditary hypertrophy of the gums and alveolar processes in a man, his three children and his grandchildren. Outside of heredity, the etiology is still vague, but some very interesting theories involving the responsibility of the endocrine glands are advanced. In this connection, the author mentions especially the thyroid and genital glands. In those cases in which entire phalanges are missing, he ascribes the anomalies to failures of development of the mesoderm as well as of the ectoderm of the embryo.

JAMES D. FRANKEL, Chicago.

Etiology, Genesis and Therapy of the "Open Bite" (M. Leist and L. Bencze, Zeitschr. f. Stomatol., 12:1171, 1928): We must differentiate between true and false open-bite cases. True cases, as the authors state, are those which develop between the first and third year of life, and are due to rickets. These cases can be cured only by means of orthodontic appliances. The false cases may develop at a later age also, and are due to some other conditions, primarily bad habits. Such cases are promptly cured by removal of the cause.

BALINT ORBAN, Chicago.

The Problem of Root-Canal Treatment (B. Gottlieb, A. M. Schwarz and G. Stein, Zeitschr. f. Stomatol., (12:1151, 1928): There has been no method up to date which could scientifically prove the value of a root-canal treatment method. We have been able to check our methods by practical clinical evidence. However, many practitioners had no confidence in only clinical findings and sacrificed all pulpless teeth. Gottlieb and his co-workers undertook the work of obtaining a method which will permit the judgment of a root-canal treatment method. This method was offered and accepted at the meeting of the F. D. I. in Köln, in the summer of 1928. Attention has already been called to this fact, in the November issue of THE JOURNAL. On the basis of ninety-six photomicrographs originating from about twenty cases, the authors describe the different results which may be obtained by different treatment methods. If we extract a tooth and implant the apex of it between the muscles of a rat, the connective tissue of the animal will react to this procedure in different ways, depending on the condition of the apex. Inflammation either of slight degree or to the extent of necrosis of the tissues will develop around the openings of the root-canal or canals or all around the apex. Most cases have, after treatment, shown this same result in different gradations, no matter what the method of treatment has been. The best results were obtained by filling the canals with silver. The authors conclude "The great variety of the cases which had been treated and controlled by us lead us to believe that this biologic method of controlling modes of root-canal treatment is reliable for its purpose." Everybody who believes that he has a technic which gives satisfaction may use this method to prove that it is satisfactory.

BALINT ORBAN, Chicago.

MISCELLANY

BOOK REVIEWS

The Principles and Technique of the Removal of Teeth. By Adolph Berger, D.D.S., Author of the Text-Book "The Principles and Technique of Oral Surgery." Associate Professor of Oral Surgery, School of Dental and Oral Surgery, Columbia University—Chief of Clinic Oral Surgery Department of Vanderbilt Clinic—Oral Surgeon to the Hospital for Joint Diseases—Oral Surgeon to Beth Israel Hospital. Illustrated with 269 engravings made from original drawings, radiographs and photographs. 350 pages. Published by Dental Items of Interest Publishing Co., Inc., Brooklyn, N. Y.

There is a very interesting "Foreword" in this book written by Henry Sage Dunning, in which he emphasizes the fact that the extraction of teeth is not such a simple operation as is sometimes supposed. He urges the necessity for the greatest care in this procedure—a statement which must be accepted by all who have had any experience in exodontia.

Dr. Berger has produced a most creditable volume, which will prove valuable alike to the student and the practitioner. He considers, in the greatest detail, the various technical procedures involved in the extraction of teeth, together with a very comprehensive chapter on the complications which may arise in the performance of this operation. This chapter is especially valuable to the beginner, and it will impress him with the fact that he must be ever on the alert in order to avoid difficulty.

The book is particularly well illustrated and the mechanical makeup is worthy of all praise. Both the author and the publisher may be congratulated on the result. It is a book that will add materially to our literature on the subject, and the profession is fortunate to have access to it.

Hygiene of the Mouth and Teeth. By Thaddeus P. Hyatt, D.D.S., F.A.C.D. Professor of Preventive Dentistry, N. Y. University Dental College, Member Fédération Dentaire Internationale, Member American Academy Periodontology, Member New York Academy of Dentistry, Member New York State Dental Society, Member Second District Dental Society, Member American Dental Association, Assistant Medical Director Metropolitan Life Insurance Company. 64 pages. Published by Brooklyn Dental Publishing Co., Brooklyn, N. Y.

This is a very attractive little book containing much information of value to the laity. Its table of contents explains quite accurately the trend of subjects. The titles are "The Foundation of Health," "Dentition," of the temporary and permanent teeth, "Structure and Integrity of the Teeth," "Decay and Its Prevention," "Germs and Focal Infection," "Sugar and the Teeth," "Home Care of Teeth and Mouth," "Schools and Teeth," and "Industry Appraises Teeth."

It will thus be seen that the author has considered the significant questions before the profession today, and has crowded as much information as possible in the given number of pages. As is the case with most books, an occasional inaccuracy has crept in. Illinois is listed as one of the states having a dental hygienist law, but no law has been passed in this State.

It seems humanly impossible to issue a book without some errors, but in any good book, these can be easily overlooked.

CORRESPONDENCE

To the Editor:

In our frenzied obsession for the latest wrinkle in artificial dentures, we have almost lost the art of making well-fitting, well-articulating and well-appearing vulcanite plates. This attempt to slight the vital values of plate making reminds me of the truck farmer who, in his eagerness to produce fancy vegetables, found himself at the end of the season with a lot of unsalable products on hand, when his customers were clambering for cabbage and potatoes. For after all is said and done, there has never been any material for full dentures discovered that could equal hard rubber. It is more adaptable to the mouth; it is better wearing and more easily mended

than any of the "Lite" family that has been tried and, in many cases, found wanting. Indeed, this same family of parvenues, if we question them closely will be recognized as relatives of old families that we knew some thirty years ago, and thought very little of, today in a new and a little more brilliant dress. They are really impostors, college bred, 'tis true, but bringing nothing to justify the extravagant claims they unfold to us, and with such consummate salesmanship. To us older practitioners, the appeal is not always convincing. It reminds me of a young relative of mine whom I took to the show the other night. It was a "period" play, and the ladies wore dresses familiar to me in my youth. "How perfectly stunning!" my young lady companion exclaimed. But to me they were commonplace, out-of-date. That illustrates how I feel about the "Lite" family. There is something very reminiscent about them, their consistence, their color and especially their breath. We have met their very near relatives before.

I suppose 75 per cent of the full dentures used today are made of rubber. It is the one material that has stood the test of time. And yet how few laboratory men know how to make a full denture rubber plate! They have been too busy flirting with the "Lite" family to pay much attention to cabbage and potatoes, too busy with this family, and attending lectures of "specialty" men who are either telling them how to get more money for their work or introducing some cureall for every dental trouble. Making rubber plates seems to be below their dignity. And what a botch they generally make of rubber plates when they do have to make them! To begin with, the plate, when it is set up and comes to us from the laboratory for the trying in is generally mounted on the articulator in the most grievous and slipshod manner. "Mounted?" they exclaim when you offer a suggestion that it might be conducive to better plates, or make it easier to obtain a normal articulation, if the models were mounted square on the jaws of the articulator, "Why, what's the difference how they are mounted; the jaws will come together, won't they? Won't the natural jaw be in the same relative position as the position of the teeth on the articulator at this point?" And you can argue and try to explain until you are blue in the face and you can't make the young laboratory man see that it makes any difference in the bite whether the median line of the model coincides with the median line of the articulator or not; or whether one side of the model is near the horizontal plane of the articulator and the opposite side is twice as far away. And yet this square mounting is of vast importance to the easy and accurate articulation of the denture in the mouth.

And as to the position of the teeth in reference to the ridges of the jaw—why, that is a matter of no importance at all to many of the commercial laboratory men of the day. You may suggest fullness here and the opposite there, but these fine points usually fall on deaf ears. They have a standardized formula for all vulcanite plates. If the mouth doesn't fit the plates they make, why, change the mouth, emulating Procrustes when his victims failed to fit his bed. Few of them have ever fitted a plate to the mouth and they are utterly ignorant of the fine points in making vulcanite plates, the matter of selecting suitable molds and shades, the matter of "animating" inanimate matter to resemble in arrangement and color the natural organs. Much of this can be done in the laboratory by an artistically minded laboratory man. There is more art in an artistically made vulcanite plate than in all the casts and inlays and gingerbread replacements that have ever been devised. "No money in 'em," they say. "Why bother with these old outworn types when we can get four times the amount of money for a little painted flapper of the Lite family. Of course we make vulcanite plates; we have to, but we hire a cheap boy to do this work at about $12 a week." And $12 a week is about $10 too much at that. No money in vulcanite plates, forsooth! Why I know a man who gets as high as $150 for a vulcanite plate, more than the average dentist gets for a "Lite" flapper. But he takes a day to set them up and another day to finish them. And when they are finished, he has given the best there is to be had in artificial dentures of whatever material or by whatever name they go.

Let us go back to the religion of our fathers—to the professional conscience of our fathers who gave to their work the best there was in them; whose first consideration was not one of dollars and cents, but "How can I serve my fellow men in the most efficient manner?" Far be it from me to minimize the importance of obtaining a just honorarium for professional services; no one de-

serves it more than the dentist who has made a comfortable, well-fitting and well-appearing plate for the man or woman without teeth. But let us not make money-getting a fetish, to the exclusion of all pride in the art of our profession. Money cannot bring to us as much satisfaction in looking back over a long career in dentistry as the consciousness that we have been a real boon to our fellow men.

Sigel Roush, M.D., D.D.S.,
Troy, N. Y.

IMPORTANT DATA WITH REFERENCE TO A PROPOSED INCREASE IN TARIFF DUTIES ON DENTAL INSTRUMENTS

Many readers of THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION are familiar with the fact that we had a long drawn out fight in 1921 and 1922 relative to the rate of duty to be placed on dental instruments in the Tariff Act of 1922, and for your information I incorporate Paragraph 359 of this Act, which is the present law:

"Surgical instruments, and parts thereof, composed wholly or in part of iron, steel, copper, brass, nickel, aluminum, or other metal, finished or unfinished, 45 per cent ad valorem; dental instruments, and parts thereof, composed wholly or in part of iron, steel, copper, brass, nickel, aluminum, or other metal, finished or unfinished, 35 per cent ad valorem. Provided, that all articles specified in this paragraph, when imported, shall have the name of the maker or purchaser and beneath the same the name of the country of origin die sunk conspicuously and indelibly on the outside, or if a jointed instrument on the outside when closed."

We secured a lower rate of duty on dental instruments because we were able to convince Congress that the dental instrument industry did not need the same amount of protection as the surgical instrument industry, as this was one of the newer industries in our country, which was largely developed of necessity during the World War.

The G. P. Pilling and Son Company, of Philadelphia, manufacturers of surgical and dental instruments, was the main contender for a higher rate of duty in the Act of 1922, and their Mr. Charles J. Pilling recently appeared before the Ways and Means Committee of the House and presented an argument for an increase in tariff duties over the present schedule and I quote the following from his statement:

"We therefore propose both a specific and ad valorem rate and that Paragraph 359 be amended to read: Surgical instruments, including hypodermic and dental needles, and parts thereof, composed wholly or in part of iron, steel, copper, brass, nickel, aluminum, or other metal, finished or unfinished, valued at not more than 25 cents per dozen, 1 cent each and 75 per centum ad valorem; more than 25 cents per dozen and not more than 50 cents per dozen, 2 cents each and 75 per centum ad valorem; more than 50 cents per dozen and not more than $1 per dozen, 5 cents each and 75 per centum ad valorem; more than $1 per dozen and not more than $2 per dozen, 12½ cents each and 75 per centum ad valorem; more than $2 per dozen and not more than $4 per dozen, 25 cents each and 75 per centum ad valorem; more than $4 per dozen and not more than $12 per dozen, 40 cents each and 75 per centum ad valorem; more than $12 per dozen and not more than $24 per dozen, 50 cents each and 75 per centum ad valorem; more than $24 per dozen, 60 cents each and 75 per centum ad valorem. The remainder of the paragraph, particularly the branding part thereof, is satisfactory to this industry provided the proposed change is made."

I also incorporate the following paragraph with reference to submitting samples and an additional paragraph giving his opinion regarding dental instruments:

"We are submitting herewith a few samples classified under paragraph 359 of the many thousand surgical instruments, used by surgeons and dentists, such as forceps, specula, hypodermic needles, retractors, tenacula, etc. Our purpose is that the committee shall understand that the making of these instruments requires far greater skill than to make scissors, yet scissors have been protected by a proper tariff and surgical instruments have not."

"Conditions affecting surgical instruments are, in the writer's opinion, identical to those of the dental instruments."

It is the purpose of the Committee on Dental Legislation of the American Dental Association to resist in every way possible any increase in tariff duties on dental instruments. We have requested a hearing before the Senate Finance Committee, and expect to file our strongest protest before this Com-

mittee. We are not advised that the Ways and Means Committee of the House have adopted any of the changes recommended by Mr. Pilling, but if they have we propose to make our fight along our 1921 and 1922 plan of campaign, when we were able to convince the Senate Finance Committee of the merits of our case, and this was later concurred in by the House members of the Conference Committee. The House had previously provided a rate of 60 per cent ad valorem on both surgical and dental instruments.

Under existing conditions it is highly important that the members of the American Dental Association and other dental organizations write direct to the members of the Senate Finance Committee and the members of the Ways and Means Committee of the House, strongly protesting against any increased tariff on dental instruments. I suggest limiting this protest to dental instruments, so as to not enter into any conflict with organized medicine since they may agree that there should be an increased duty on surgical instruments, as this may be more properly termed an infant industry. It would also be helpful to write other Senators and Congressmen, but we must give especial attention to the members of the two Committees heretofore mentioned and which I incorporate as follows:

SENATE FINANCE COMMITTEE

Reed Smoot, Chairman, Utah; George P. McLean, Conn.; James E. Watson, Ind.; David A. Reed, Pa.; Samuel M. Shortridge, Calif.; Walter E. Edge, N. J.; James Couzens, Mich.; Frank L. Greene, Vt.; Charles S. Deneen, Ill.; Henry W. Keyes, N. H.; F. M. Simmons, N. C.; Peter G. Gerry, R. I.; Pat Harrison, Miss.; William H. King, Utah; Thomas F. Bayard, Del.; Walter F. George, Ga.; David I. Walsh, Miss.; Alben W. Barkley, Ky.; Elmer Thomas, Okla.

COMMITTEE ON WAYS AND MEANS

Willis C. Hawley, Chairman, Ore.; Allen T. Treadway, Mass.; Isaac Bacharach, N. J.; Lindley H. Hadley, Wash.; Charles B. Timberlake, Colo.; Henry W. Watson, Pa.; James C. McLaughlin, Mich.; Charles C. Kearns, Ohio; Carl R. Chindblom, Ill.; Frank Crowther, N. Y.; Richard S. Aldrich, R. I.; Harry A. Estep, Pa.; C. William Ramseyer, Iowa; Frederick M. Davenport, N. Y.; John N. Garner, Texas; James W. Collier, Miss.; Charles R. Crisp, Ga.; John F. Carew, N. Y.; Whitmell P. Martin, La.; Henry T. Rainey, Ill.; Cordell Hull, Tenn.; Clement C. Dickinson, Mo.; Robert L. Doughton, N. C.; Heartsill Ragon, Ark.

Thanking you in advance for the co-operation that is necessary in such legislative action.

Respectfully submitted,

Homer C. Brown, *Chairman,*
Committee On Dental Legislation,
American Dental Association.

March 8, 1929
609 Hartman Building,
Columbus, Ohio.

NEWS

Dr. Goldberg Awarded Morris L. Chaim Prize: The Morris L. Chaim prize for 1928 has been awarded by the First District Dental Society of the State of New York to Samuel Goldberg, D.D.S., M.S., for his paper on "Biometrics of Identical Twins from the Dental Viewpoint." Dr. Goldberg has been in Chicago for some time doing graduate work and conducting research on the teeth of identical twins under Professor Neuman of Chicago University.

Virginia College Receives Grant: The Chemical Foundation, Inc., of New York City has made a grant to the Medical College of Virginia, at Richmond, to make it possible to employ, for a three-year period, a full-time expert to enlarge its present program of research in chemistry as related to medicine, surgery and dentistry. The special laboratory for this work will also be considerably enlarged.

Deaths

Fuller, Edwin S., Dayton, Ohio; Ohio State University College of Dentistry, 1895; died, January 31; aged 59.

Pennington, Samuel C., Catonsville, Md.; died, November 12.

ANNOUNCEMENTS

CALENDAR OF MEETINGS*

NATIONAL SOCIETIES

American Dental Association, Washington, D. C., Oct. 7-11, 1929.

American Dental Assistants Association, Washington, D. C., Oct. 7-10, 1929.

American Full Denture Society, Washington, D. C., Oct. 1, 1929.

American Society of Orthodontists, Estes Park, Colo., July 15-19, 1929.

STATE SOCIETIES

District of Columbia, at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June inclusive.

April (1929)

Alabama, at Birmingham (16-18).
Arizona, at Phoenix (8-9).
Connecticut, at Waterbury (April 30-May 2).
Kansas, at Wichita (April 29-May 2).
Kentucky, at Louisville (9-11)
Mississippi, at Jackson (22-24).
New Jersey, at Asbury Park (10-12).
Oklahoma, at Oklahoma City (22-25).
Texas, at Beaumont (16-19).
Virginia, at Danville (April 30-May 2).

May (1929)

Arkansas, at Little Rock (20-22).
Illinois, at Springfield (14-16)
Indiana, at Indianapolis (20-22).
Iowa, at Cedar Rapids (7-9)
Maryland, at Baltimore (6-8).
Massachusetts, at Boston (6-10).
Missouri, at St. Joseph (12-14).
Nebraska, at Omaha (20-23).
New York, at Rochester (15-17).
North Dakota, at Grand Forks (14-16).
Pennsylvania, at Scranton (14-16).
Southern California, at Los Angeles (6-7).
Vermont, at Burlington (22-24).
West Virginia, at White Sulphur Springs (27-29).

June (1929)

Colorado, at Colorado Springs (17-19).
Georgia, at Atlanta (12-14).
Maine, at South Poland (20-22).
Michigan, at Detroit (18-20).
Nevada, at Reno (1).

July (1929)

California, at San Francisco (8-12).
Oregon, at San Francisco (8-12).
South Dakota, at Rapid City (1-2).
Utah, at San Francisco (8-12).
Washington, at San Francisco (8-12).
Wisconsin, t Milwaukee (9-11).

American Dental Society of Europe, London, England, July 29, 1929.

Dental Congress of Latin America, Rio de Janeiro, Brazil, July 14-21, 1929.

Pacific Coast Dental Conference, San Francisco, July 8-12, 1929.

*Announcements must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

MEETINGS OF STATE BOARDS OF DENTAL EXAMINERS

Arizona, at Flagstaff, beginning July 29, 1929. Eugene McGuire, Secretary, 420 Security Bldg., Phoenix.

Connecticut, at Hartford, June 27-29, 1929. Arthur B. Holmes, Recorder, 80 Central Ave., Waterbury.

Indiana, at Indianapolis, June 17, 1929, J. M. Hale, Secretary-Treasurer, Mt. Vernon.

Iowa, at Iowa City, May 27-30. H. D. Grefe, Director, Capitol Bldg., Des Moines.

Kentucky, at Louisville, June 7-11, 1929. Robert L. Sprau, Secretary, 970 Baxter Ave., Louisville.

Maine, at Augusta, June 24-26, 1929. G. W. MacKay, Secretary, Millinocket.

Massachusetts, at Boston, June 11-15, 1929. W. Henry Grant, Secretary, Room 146 State House, Boston.

Minnesota, at Minneapolis, June 18. F. E. Cobb, Secretary, 601 Donaldson Bldg., Minneapolis.

New Jersey, at Trenton, June 24-29, 1929. John C. Forsyth, Secretary, 148 West State St., Trenton.

Pennsylvania, at Philadelphia and Pittsburgh, June 27-29, 1929. Alexander H. Reynolds, Secretary, 4630 Chester Ave., Philadelphia.

Rhode Island, at Providence, June 25-27. Albert L. Midgley, Secretary, 1108 Union Trust Bldg., Providence.

AMERICAN FULL DENTURE SOCIETY

The next meeting of the American Full Denture Society will be held at Washington, D. C., the Friday preceding the Seventy-First Annual Session of the American Dental Association.

ROBERT JASMAN, *Secretary,*
704 Citizens Nat. Bank Bldg.
Sioux Falls, S. D.

DENTAL INTERNSHIP AT LENOX HILL HOSPITAL

The position of dental intern at the Lenox Hill Hospital will be vacant, September 1. The term of service is one year, with full maintenance. Apply in writing not later than April 15 to

GEORGE F. SAUER, *Superintendent,*
112 E. 77th St.,
New York City.

ARIZONA STATE DENTAL SOCIETY

The Arizona State Dental Society will hold its next meeting in Phoenix, April 8-9.

C. E. MATTESON, *President,*
Tucson.

NEW JERSEY STATE DENTAL SOCIETY

The New Jersey State Dental Society will hold its fifty-ninth annual meeting in the Berkeley-Carteret Hotel, Asbury Park, April 10-12. April 10, C. N. Johnson, Chicago, will speak on "Dental Economics;" April 11, H. A. Maves, Minneapolis, will speak on "The Control of Variables in the Casting Process," and Sterling V. Mead, Washington, D. C., on "Diseases of the Mouth and Their Surgical Treatment." Theodor Blum, New York City, will discuss Dr. Mead's paper. In addition to the papers, there will be approximately twenty clinics of a very interesting character. Members are directed to bring membership cards. For information regarding exhibits, address H. J. Gibbins, 221 S. Orange Ave., Newark; clinics, K. C. Pruden, 44 Church St., Paterson; general items, F. K. Heazelton, Secretary, 223 East Hanover St., Trenton.

CONNECTICUT DENTAL COMMISSION

The Connecticut Dental Commission will meet at Hartford, June 27-29, to examine applicants for license to practice dentistry and dental hygiene, and to transact any other business proper to come before them. For further information, apply to

ARTHUR B. HOLMES, *Recorder,*
80 Central Ave.,
Waterbury.

MASSACHUSETTS BOARD OF DENTAL EXAMINERS

The Massachusetts Board of Dental Examiners will hold an examination for registration for both dentists and oral hygienists in the City of Boston, June 11-15. Full information, application blanks, etc., can be secured at the office of the secretary, Room 146, State House, Boston. All applications must be filed at the office of the secretary at least ten days before the date set for the examination.

W. HENRY GRANT, *Secretary.*

PACIFIC COAST DENTAL CONFERENCE

The Pacific Coast Dental Conference group, consisting of British Columbia, Washington, Oregon, Idaho, Utah, Nevada, Southern California and California State associations, will hold their second triennial meeting in San Francisco, July 8-12. All members of the A. D. A. are cordially invited. Further information can be had from the secretary, F. T. West, 2180 Washington St., San Francisco.

DICKSON G. BELL,
209 Post St.,
San Francisco.

MAINE BOARD OF DENTAL EXAMINERS

The Maine Board of Dental Examiners will hold its next examination at the State House, Augusta, June 24-26. Application with photograph and fee of $20 (hygienists, $10) must be in the hands of the secretary not later than June 14. For further information and application blank, apply to

G. W. MACKAY, *Secretary,*
Millinocket.

PENNSYLVANIA STATE DENTAL COUNCIL AND EXAMINING BOARD

The next regular examination of the Pennsylvania State Dental Council and Examining Board will be held in Philadelphia and Pittsburgh, Wednesday-Saturday, June 26-29. The theoretical examination in Philadelphia will be held at the College of Pharmacy Building, 43d and Woodland Ave., and at the University of Pittsburgh, Pittsburgh. The practical examination will be held in the Evans Institute, 40th and Spruce streets, Philadelphia, and the University of Pittsburgh, Pittsburgh, Saturday, June 29, at 8:30 a. m. An examination will be held in the fundamental subjects of the dental course, Wednesday and Thursday, June 26-27, in Room 976, City Hall, Philadelphia, and the University of Pittsburgh, Pittsburgh. An examination will also be held for dental hygienists in Room 976, City Hall, Philadelphia, and the University of Pittsburgh, June 27-29. All applicants for the dental examination must have had one year of college work after the four years of high school before beginning the dental course in order to be eligible for the examination in June, 1929, and thereafter. Application papers may be secured from the Department of Public Instruction, Harrisburg. For further information, address

ALEXANDER H. REYNOLDS, *Secretary,*
4630 Chester Ave.,
Philadelphia.

IOWA STATE BOARD OF DENTAL EXAMINERS

The Iowa State Board of Dental Examiners will meet at the State University of Iowa, College of Dentistry, Iowa City, May 27-30, at 9:00 a. m., for the purpose of examining applicants for license to practice dentistry in Iowa. An examination for dental hygienists will also be given. All papers and credentials must be filed with the department at least fifteen days prior to date of examination. For further information and application blanks, address the State Department of Health, Capitol Building, Des Moines, Iowa.

H. W. GREFE, *Director,*
Examinations and Licensures.

CANADIAN DENTAL ASSOCIATION AND WESTERN CANADA DENTAL ASSOCIATION

A joint meeting of the Canadian Dental Association and the Western Canada Dental Association will be held at the Hotel Saskatchewan, Regina, Sask., June 6-8, 1929.

A cordial invitation is extended to members of the A. D. A. in good standing.

J. STANLEY BAGNALL, *Sec'y-Treas.,*
Canadian Dental Association,
77½ Larch St.,
Halifax, Nova Scotia.

PENNSYLVANIA STATE DENTAL SOCIETY

The Sixty-First Annual Meeting of the Pennsylvania State Dental Society will be held at Scranton, May 14-16, 1929. Leslie Waddill, Jenkins Arcade, Pittsburgh, is manager of exhibits.

C. W. HAGAN, *Secretary,*
1011 Macon Ave., Swissvale P. O.
Pittsburgh

POSTGRADUATE SUMMER SCHOOL FOR DENTAL HYGIENISTS

The fourth annual summer session of postgraduate study for dental hygienists will open at State Teachers College in Buffalo, July 8, 1929, and will continue through Friday, August 16. While this course is primarily designed for those wishing to qualify as dental hygiene teachers in New York State, the work presented should prove of value to any dental hygienist in her contacts with the public.

A parallel course for school nurses is also given. These courses have been approved by the state education department as meeting the requirements for certification as a dental hygiene teacher and school nurse teacher. Tuition is free to residents of New York State. Twenty-five dollars is charged nonresidents. Living expenses approximate from $10.00 to $15.00 per week. Classes are held five days a week from July 8 to August 16.

Complete announcement of the course and applications for admission will be sent on request by S. R. Meaker, Supervisor of Oral Hygiene, State Education Department, Albany, N. Y.

MINNESOTA STATE BOARD OF DENTAL EXAMINERS

The Minnesota State Board of Dental Examiners will hold their next meeting June 18, 1929, College of Dentistry, University of Minnesota, Minneapolis. Application blanks may be obtained from the secretary and must be filed with him not later than June 10.

F. E. COBB, *Secretary,*
601 Donaldson Bldg.,
Minneapolis.

CONNECTICUT DENTAL HYGIENISTS' ASSOCIATION

The fifteenth annual meeting of the Connecticut Dental Hygienists' Association will be held at the Wilby High School, Waterbury, Wednesday, May 1.

VERA C. RANDALL, *Secretary,*
215 Whitney Ave.,
New Haven

RHODE ISLAND BOARD OF REGISTRATION IN DENTISTRY

A meeting of the Rhode Island Board of Registration in Dentistry for the examination of candidates will be held at the State House, Providence, Tuesday-Thursday, June 25-27, beginning each day at 9 a. m. Candidates shall present to the secretary of this board, at least one week before the examination, a written application on a form provided by the board, together with the examination fee of $20.

ALBERT L. MIDGLEY, *Secretary,*
1108 Union Trust Bldg.,
Providence.

ONTARIO DENTAL ASSOCIATION

The sixty-second convention of the Ontario Dental Association will be held at the King Edward Hotel, Toronto, May 27-30. Members of the American Dental Association and state societies are cordially invited as guests.

FRED J. CONBOY, *Sec'y-Treas.,*
East Block, Parliament Bldgs.,
Toronto.

SOME RECENT BOOKS
Available for Circulation from the
LIBRARY BUREAU
AMERICAN DENTAL ASSOCIATION*

Appleton, J. L. T., Jr.	Bacterial infection with special reference to dental practice. Philadelphia, Lea & Febiger, 1925.
Appleton, J. L. T., Jr., & Bryant, C. K.	Laboratory guide in bacteriology. Philadelphia, Lea & Febiger, 1928.
Barail, L. C.	High-frequency in dentistry. Paris, France, La Verrerie Scientifique, 1927. (Pamphlet.)
Berger, Adolph	Principles and technic of oral surgery. Brooklyn, Dental Items of Interest Pub. Co., 1927.
Berger, Adolph	Principles and technique of the removal of teeth. Brooklyn, Dental Items of Interest Pub. Co., 1929.
Bilpodiwala, M. C.	Care of the teeth, or layman's handbook of dentistry. Bombay, India, Author, 1927.
Box, H. K.	Treatment of the periodontal pocket. Toronto, University of Toronto Press, 1928.
Broderick, F. W.	Dental medicine. St. Louis, Mosby, 1928.
Broderick, R. A.	Dental bacteriology. Outlines of dental science. Vol. 2. Edinburgh, Livingstone, 1926.
Broomell, I. N., & Fischelis, Philipp	Anatomy and histology of the mouth and teeth. Philadelphia, Blakiston, 1925.
Brothers, E. D.	Dental jurisprudence. St. Louis, Mosby, 1928.
Brown, A. J.	Dental metallurgy. Outlines of dental science. Vol. 11, New York, Wood, 1928.

Brown, W. L.	Endocrines in general medicine. St. Louis, Mosby, 1927.
Buckley, J. P.	Modern dental materia medica, pharmacology and therapeutics. Philadelphia, Blakiston, 1926.
Bulleid, Arthur	Textbook of bacteriology for dental students. St. Louis, Mosby, 1927.
Bunting, R. W.	A text-book of oral pathology for students and practitioners of dentistry. Philadelphia, Lea & Febiger, 1929.
Burchard, H. H., & Inglis, O. E.	Textbook of dental pathology and therapeutics for students and practitioners. Philadelphia, Lea & Febiger, 1926.
Burkhart, H. J.	Care of the mouth and teeth. (National Health Series). New York, Funk & Wagnalls, 1928.
Buxton, J. L. D.	Dental pathology. Outlines of dental science. Vol. 7. New York, Wood, 1927.
Buxton, J. L. D.	Dental surgery. Outlines of dental science. Vol. 8. New York, Wood, 1927.
Cattell, Psyche	Dentition as a measure of maturity. Cambridge, Harvard University Press, 1928.
Clapp, G. W.	Life and Work of James Leon Williams. New York, Dental Digest, 1925.
Clark, C. A.	Dental radiography. Outlines of dental science. Vol. 5. New York, Wood, 1926.
Colyer, Stanley	Chronic infection of the jaws: a short radiological and clinical study. New York, Macmillan, 1926.
Dental Board of the United Kingdom	Four lectures on "general anaesthesia." London, Dental Board of the United Kingdom, 1926.
Dental Board of the United Kingdom	Three lectures on "dental alloys." Delivered under the auspices of the Dental Board of the United Kingdom. London, Dental Board of the United Kingdom, 1927.
Endleman, Julio	Special dental pathology: a treatise for students and practitioners. St. Louis, Mosby, 1927.
Federspiel, M. N.	Harelip and cleft palate. St. Louis, Mosby, 1927.
Feldman, M. H.	Manual of exodontia. Philadelphia, Lea & Febiger, 1926.
	First International Orthodontic Congress: held at New York City, August 16-20, 1926. St. Louis, Mosby, 1927.
Fones, A. C.	Mouth hygiene; a textbook for dental hygienists. Philadelphia, Lea & Febiger, 1927.
Fones, A. C.	Preventive dentistry. Philadelphia, Lea & Febiger, 1925.
Foote, J. S.	Bone as a measure of development: When and how we acquired our teeth. Chicago, American Dental Association, 1928.
Gies, W. J.	Dental education in the United States and Canada. New York, Carnegie Foundation, 1926.
Goepp, R. M.	Dental state board questions and answers. Philadelphia, Saunders, 1928.
Goslee, H. J.	Principles and practice of crown and bridgework. Brooklyn, Dental Items of Interest Pub. Co., 1926.
Greenfield, A. L.	Interpretation of dental radiograms. Rochester, N. Y., Ritter Dental Mfg. Co., 1926.
Guerini, Vincenzo	Life and works of Guiseppangelo Fonzi. Philadelphia, Lea & Febiger, 1925.
Gwinn, C. D.	Textbook of exodontia. Philadelphia, Lea & Febiger, 1927.
Hackh, I. W. D.	Chemical reactions and their equations. Philadelphia, Blakiston, 1928.
Haden, R. L.	Dental infection and systemic disease. Philadelphia, Lea & Febiger, 1928.
Hanau, R. L.	Dental engineering. Buffalo, N. Y., Author, 1926.

Hanau, R. L.	Hanau intraoral method vs. Gysi extraoral method. Buffalo, N. Y., Author, 1927.
Hartman, L. L.	Teeth and the mouth. New York, Appleton, 1927.
Head, Joseph	Everyday mouth hygiene. Philadelphia, Saunders, 1925.
Headridge, David, & Gibson, S. K.	Dental anatomy, human and comparative. Outlines of dental science. Vol. 6. New York, Wood, 1928.
Herbst, Emil, & Apffelstaedt, Max	Atlas und grundriss der missbildungen der kiefer und zähne. München, J. F. Lehmanns, 1928.
Hertzler, E.	Technic of local anesthesia. St. Louis, Mosby, 1925.
Hess, Walter, & Zurcher, Ernst	Anatomy of the root-canals of the teeth. New York, Wood, 1925.
Hogeboom, F. E.	Practical periodontia or juvenile operative dentistry and public health dentistry. St. Louis, Mosby, 1927.
Jamieson, J. D. H.	Operative dentistry. Outlines of dental science. Vol. 9. New York, Wood, 1927.
Jordan, M. Evangeline	Operative dentistry for children. Brooklyn, Dental Items of Interest Pub. Co., 1927.
Kanner, Leo	Folklore of the teeth. New York, Macmillan, 1928.
Kells, C. E.	Dentist's own book, including a complete bookkeeping and recording system. St. Louis, Mosby, 1925.
Kells, C. E.	Three score years and nine. New Orleans, The Author, 1926.
Kennedy, Edward	Partial denture construction. Brooklyn, N. Y., Dental Items of Interest Pub. Co., 1926. Brooklyn, 1928.
LeGro, A. L.	Ceramics in dentistry. Brooklyn, Dental Items of Interest Pub. Co., 1926.
Leriche, R. & Policard, A.	Normal and pathological physiology of bone. St. Louis, Mosby, 1928.
Logan, J. D.	Dental prosthetics. Outlines of dental science. Vol. 4. Edinburgh, Livingstone, 1926.
Marsden, P. H.	Dental materia medica. Outlines of dental science. Vol. 3. Edinburgh, Livingstone, 1926.
McCollum, E. V., & Simmonds, Nina	Food, nutrition and health. Baltimore, Authors, 1928.
McCoy, J. D.	Applied orthodontia. Philadelphia, Lea & Febiger, 1927.
McGaw, Emma J.	Dental assistant. St. Louis, Mosby, 1926.
Marshall, J. A.	Diseases of the teeth; their diagnosis and treatment. Philadelphia, Lea & Febiger, 1926.
Mead, S. V.	Diseases of the mouth. St. Louis, Mosby, 1928.
Moorehead, F. B., & Dewey, Kaethe W.	Pathology of the mouth. Philadelphia, Saunders, 1925.
Nevin, Mendell, & Puterbaugh, P. G.	Conduction, infiltration and general anesthesia in dentistry. Brooklyn, Dental Items of Interest Pub. Co., 1927.
Orban, Balint	Dental histology and embryology. Chicago, Rogers Printing Co., 1928.
Ottolengui, Rodrique	Table talks on dentistry. Brooklyn, Dental Items Interest, 1928.
Owre, Alfred	Prunes or pancakes. Minneapolis, University of Minnesota Press, 1926.
Posner, J. J.	Minor oral surgery simplified. Philadelphia, Patterson & White, 1928.
Prinz, Hermann	Dental materia medica and therapeutics. St. Louis, Mosby, 1926.
Prinz, Hermann	Diseases of soft structures of teeth. Philadelphia, Lea & Febiger, 1928.
Raper, H. R.	Clinical preventive dentistry. Rochester, N. Y., Ritter Dental Mfg. Co., 1926.

Reidy, M. J.	This tooth proposition. Des Moines, Iowa, Author, 1927.
	Ritter practice building suggestions. Rochester, N. Y., Ritter Dental Mfg. Co., 1926.
Roberts, Lydia J.	Nutrition work with children. Chicago, University Chicago Press, 1927.
Rose, Mary Swartz	Foundations of nutrition. New York, Macmillan, 1927.
Shaw, D. M.	Dental prosthetic mechanics. London, Arnold, 1927.
Sicher, Harry, & Tandler, Julius	Anatomie für zähnarzte. Vienna, Julius Springer, 1928.
Silverman, S. L.	Principles and practice of oral surgery. Philadelphia, Blakiston, 1926.
Simon, P. W.	Fundamental principles of a systematic diagnosis of dental anomalies. Boston, Stratford, 1926.
Simon, W., & Base, Daniel	Manual of chemistry. Philadelphia, Lea & Febiger, 1927.
Simpson, C. O.	Technic of oral radiography. St. Louis, Mosby, 1928.
Smith, G. F. R.	Dental anesthesia. Outlines of dental science. Vol. 1. Edinburgh, Livingstone, 1926.
Sorrin, Sidney, & Miller, S. C.	Practice of periodontia. New York, Macmillan, 1928.
Steadman, F. St. J.	Pyorrhea alveolaris. St. Louis, Mosby, 1927.
Stoloff, C. I.	Your teeth. New York, E. P. Dutton, 1928.
Tanguy, T. V.	Science and practice of actinotherapy. St. Louis, Mosby, 1928.
Turner, C. R., & Anthony, L. P.	American textbook of prosthetic dentistry. Philadelphia, Lea & Febiger, 1928.
Tyree, C.	Dental Health in the prevention of disease. London, Kentucky, Author, 1927.
Wallace, J. S.	Teeth and health. London, Faber & Gwyer, 1926.
Wallace, J. S.	Variations in the form of the jaws, with special reference to their etiology and their relation to the occlusion of the dental arches. New York, Wood, 1926.
Wang, C. Y.	Handbook of pathology. New York, Wood, 1925.
Ward, L. (Ed.)	American textbook of operative dentistry. Philadelphia, Lea & Febiger, 1926.
Weinberger, B. W.	Orthodontics: an historical review of its origin and evolution. 2 vols. St. Louis, Mosby, 1926.
Wells, F. M.	Sound teeth in a sound body. Montreal, Author, 1926.
Winter, G. B.	Principles of exodontia, as applied to the impacted mandibular third molar. St. Louis, American Medical Book Co., 1926.
Winter, Leo	Textbook of exodontia. St. Louis, Mosby, 1927.
Zoethout, W. D.	Textbook of physiology. St. Louis, Mosby, 1928.

*Books may be borrowed by members of the Association for a period of one week after date of receipt; and if not reserved for some one else, the period will be extended on request. A deposit of $2.00 for each volume asked for should accompany all requests for books. This will be refunded on return of books.